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Standards

THE chemical, chemical engineering and associated industries are among the more enlightened of the community where the subject of standardisation and simplification is concerned, but elsewhere in industry there are still some misconceptions of what standards imply for the manufacturer and his product. This is a pity, because there is always a pressing need to economise in time, capital, natural resources or labour, and the use of standards may help considerably in achieving this.

The suggestion has been made that standardisation may introduce a rigidity which will hinder the development of a product or process. Even in such rapidly developing fields as television and synthetic fibres, however, production planning must be stabilised for a sufficient period to make efficient work possible. Research and development work must be carried out independently of production, and the newest technical knowledge applied. Far from inhibiting development, the formulation of a standard often shows the need for research and stimulates it. Differences in design and material specifications may largely be due to a lack of knowledge of properties and performance. Well-planned research can determine whether this is so, but only if results are incorporated in published standards can the widest application of such knowledge take place. On this view, standards and research are the twin supports of industrial progress.

These considerations are discussed in a report by P.E.P. (Political and Economic Planning), which deals with standards and their use in British industry as well as the question of foreign and international standards. It is pointed out that, in Britain, it is industry itself which, through the British Standards Institution, most actively promotes work on national standards. Many of the larger firms carry out internal work on standards for their own needs, and there are also standards agreed between firms in an industry. While a very large number of trade associations act as the channel between their members and the B.S.I., a number also prepare standards agreed by their own members. The most extensive activities of the British Plastics Federation, for instance, are in the field of technical information, standardisation and quality control, while the Association of British Chemical Manufacturers was largely responsible for initiating the organisation of British chemical standardisation.

Manufacturers and engineers who are interested in the problems of using standards in industry will find some interesting points in the report previously

referred to, which is published as a broadsheet ('Planning,' No. 381), and also in a companion to it (No. 382) which considers in some detail the organisation and activities of the British Standards Institution. Both can be obtained, at 2s. 6d. each, from P.E.P. at 16 Queen Anne's Gate, London, S.W.1.

Acid from waste pickle liquor

THE British steel industry is the fifth largest user of sulphuric acid in the country. Large quantities —about 100,000 tons in 1954—are used to remove millscale and rust from the steel. Disposing of this waste pickle liquor, consisting of a solution of iron sulphate in water together with a little unused sulphuric acid, presents the steelmaker with a difficult problem. Some firms treat the waste pickle by a crystallisation process to extract the iron sulphate, subsequently selling it. The market is, however, limited and the problem of disposal is still unsolved for those firms not using the crystallisation process, since there are legal obstacles in the way of getting rid of a pollutant *via* the drainage system. How, then, can the steelmaker deal with all this liquid residue and possibly recover from it something of value?

A method of solving both problems simultaneously, by treating the iron sulphate so that it is converted into iron oxide and fresh sulphuric acid, has been developed by the British Iron and Steel Research Association. The iron sulphate obtained after crystallisation by conventional means is roasted at 800 to 900°C., decomposing into iron oxide and sulphur dioxide gas. The gas is cleaned, compressed and bubbled with air into an 'autoxidation' tower containing water. In the presence of ozone and a trace of manganese sulphate the gas combines with oxygen and water to form new sulphuric acid which is piped back to the pickling tanks. This 'autoxidation' process was first tried out in connection with the manufacture of alumina by the Tennessee Valley Authority during the last war, but has been extensively developed by B.I.S.R.A. to meet the needs of the steel industry.

After the method had been successfully tested in the South Wales laboratory of B.I.S.R.A., a pilot plant was built in the Kings Dock works of the Steel Co. of Wales Ltd. The project was financed by that company jointly with Simon Carves Ltd. and B.I.S.R.A. Trials during the past few months have produced acid up to 40% concentration, which is more than strong enough for pickling. A preliminary economic assessment suggests that, with a plant capable of handling 10 tons of acid daily (that is, some 17 tons of ferrous sulphate monohydrate) and upwards, valuable savings can be effected in the cost of pickling.

As is pointed out in *B.I.S.R.A. Survey*, in which the foregoing facts are revealed, there are still some problems to be solved in the transition from pilot plant to full-scale works plant, but already it is clear that the system is practical and efficient. Costs can be lowered, and the waste liquor reduced to a harmless, non-pollutive condition.

'Monel's' fiftieth birthday

THIS year marks the fiftieth anniversary of the production, by International Nickel Co. of Canada Ltd., of the first of the *Monel* series of high-nickel copper alloys. The first alloy to which this trade mark was applied contained about two-thirds nickel and one-third copper and was originally produced as a 'natural' alloy from the ore of Inco's Creighton mine in the Sudbury district of Ontario. The alloys owe their origin to the late Robert C. Stanley, a former chairman and president of International Nickel, and the trade mark applied to them was adopted from the name of the late Ambrose Monell, the patentee of the original method of manufacture, who at the time of the discovery and early development was president of the company. The corrosion resistance, strength and other properties of the *Monel* alloys have made them well known to chemical engineers and others in a great number of industries.

Remarking on *Monel's* fiftieth anniversary in a letter to shareholders recently, Mr. John F. Thompson, the president of the company, points out that the initial *Monel* alloy was one of the forerunners of today's 'alloy age' and the pioneer that led to the development of many of the more than 50 nickel alloys the company now produces.

New reactor at Harwell

A FULL-SCALE, very low-power model of the Dounreay fast reactor has been built at Harwell and should be in operation before the end of this year. It has been named 'Zeus' (zero energy uranium system) and will provide data relating to the design and operation of the Dounreay experimental plant which is designed to produce electricity.

'Zeus' is a fast reactor like 'Zephyr' (the zero energy fast reactor) and the reacting core contains only the fuel, its canning material and the coolant. There is no moderating material like heavy water or graphite to slow down the neutrons. However, being a full-scale model of an actual power reactor, it is much larger than 'Zephyr.' The fuel is uranium highly enriched in Uranium 235 (from the diffusion plant at Capenhurst), instead of the plutonium fuel used in 'Zephyr.' The fuel is in the form of long tubes which are mounted vertically to form a hexagonal-shaped core.

The core is surrounded by an envelope or blanket of natural uranium, whose purpose is to absorb the neutrons from the core and so produce plutonium. The Dounreay reactor and 'Zeus' are both breeder reactors in the sense that the amount of plutonium produced in the reactor should exceed the amount of Uranium 235 burned in the core. It is not expected that the breeding margin will be as high as it was in 'Zephyr,' where the amount of fresh plutonium produced in the reactor was found to be about double the amount consumed in the core.

The operating power level of 'Zeus' will be only about one millionth of that of the proposed Dounreay reactor. This will be sufficient for the experimental

Comical Engineering Terms

"CONE CRUSHER"

studies which are to be carried out on ' Zeus,' without leading to many of the engineering difficulties associated with operation at high power. Staff from the Industrial Group of the Atomic Energy Authority, who will be responsible for running the high-power reactor at Dounreay, will take part in the operation of ' Zeus.'

The original purpose of the development of fast reactors was the efficient utilisation of the uranium, made possible by breeding. Because of the complex technical problems which they pose, fast reactors will not play a prominent part in the early stages of the utilisation of atomic energy, but when they do come into widespread use they will make it possible for a substantial supply of fissile material to be obtained economically from a relatively modest supply of uranium.

Science and management

AN increasing number of science graduates are entering industry and many future management posts will eventually be filled by young men with this type of background. Is it necessary to orient these men *during their university training* to industrial conditions and to introduce them to those special techniques and problem areas which are the concern of management? How can this be done?

These important questions apply as much to chemical engineers as to anyone and a panel which will discuss them at the British Institute of Management National Conference at Harrogate next month will include at least one chemical engineering authority—Prof. M. B. Donald, of University College, London. The conference will have as its theme ' The Impact of Science on Management in the Future.' Subjects to be discussed during the 24 sectional meetings include automation, the uses of radioactive isotopes, the electronic processing of data and the changes brought about by recently developed materials and processes.

Gold mines start a ' bone rush '

URANIUM production in the gold fields has given quite a fillip to the production of glue, which has apparently become an important commodity for the processing of uranium ores. It seems that it is used as a flocculating agent and as a result the material is made easier to filter. At any rate the demand for glue has started a great hunt for bones—bones of any age or origin—and sent buyers into the remote corners of the bushveld. For beyond Bushbuchridge and Acornhoek in the Transvaal lowveld and in the huge jungle-covered areas of the Limpopo valley lies an almost inexhaustible supply of old bones—the skeletons of wild animals that have perished in the years, and indeed in the centuries, that have passed. Trading stations in remote native reserves are doing a big trade in old bones. The controlled price of £7 a ton has brought wealth to the native tribes beyond the Olifants River and the Crocodile River, who so assiduously scratch in the grass and among the stones for skulls and ribs. Bones of elephants, hippo, crocodile, eland or kudu are all going into the great cauldrón from which the world is getting its supply of atomic energy—and atom bombs.

In addition to the glue, fat is extracted from the bones and sold to the soap factories. No doubt some of it also goes to make candles to help lighten Darkest Africa. Bone also yields fertiliser as well as phosphatic supplementary food for the South African cattle herds. Thus has the bushveld become a vital source of raw materials to South African factories as well as an essential partner in the uranium industry and hand maiden to research work on nuclear fission.

Chemical conservation of water

A CHEMICAL answer to one of Kenya's recurrent problems—water scarcity—has been devised by the East African Meteorological Department in collaboration with the East African Industrial Research Organisation. Hundreds of millions of gallons of water in reservoirs and dams are lost each year by evaporation, and to prevent these losses the surfaces of the dams and reservoirs are being misted with a monomolecular film of cetyl alcohol which markedly retards evaporation. The idea has been used in Australia, but Mr. H. B. Stent, formerly of Manchester, who is director of the East African Industrial Research Organisation, has devised a means of preparing the cetyl alcohol in pellet form which is more effective than the flakes used hitherto.

The cetyl alcohol is imported from Britain in lump form. Mr. Stent's pelleting process consists of maintaining a constant head of molten cetyl alcohol feeding a manifold equipped with fine jets, each of which is immersed in a column of water. The molten alcohol leaves the jets in liquid droplets which rise through the water columns and solidify before they reach the top, overflowing into a perforated collecting vessel.

The pellets are enclosed in fine copper-mesh baskets in the framework of box-like rafts, fleets of which are being launched and anchored across large expanses of

Kenya's water supplies. The initial tests are being based on 1 lb. of pellets to each raft, and one raft to each acre of water surface. The resultant film, even when broken by wind and waves, automatically repairs itself by the spread of further cetyl alcohol.

The pellets, costing around 2s. 6d./lb. and estimated to last several years of immersion, are contained in 106 rafts which have been floated on the 88-acre, 415-million-gal. Nairobi Dam. If the success is maintained of experiments in the evaporation pans of the East African Meteorological Department's station in Nairobi, when up to 70% reduction in evaporation was recorded, a saving on Nairobi Dam of some 30 million gal./year is envisaged.

Application by spraying alcohol dissolved in a solvent has been considered, but experience suggests the advantage of having a constant source of supply, so that if the film is disturbed mechanically a little more alcohol will seep out and rejoin the film.

Sulphuric acid as a rubber coagulant

IS sulphuric acid satisfactory as a coagulant for natural rubber? Investigations some 20 or 30 years ago cast some doubts on this subject, and manufacturers expressed considerable alarm at the continued use of sulphuric acid, particularly if they were not warned of the method of preparation before negotiating the purchase of the rubber. Recent experiments, however, show that the properties of rubber before, during and after vulcanisation remain unimpaired, providing that the amount of sulphuric acid is kept at a reasonable level.

These experiments have been described by L. L. Best and S. H. Morrell and published by the Institution of the Rubber Industry in their *Transactions*. The data indicate that the use of sulphuric acid in normal amounts as a coagulant has no deleterious effect on the properties of the raw rubber or on vulcanisates made from the raw rubber. When four times the normal dosage of sulphuric acid is employed there is a slight softening of the raw rubber, but all samples examined had properties within the normal range of plasticity associated with natural rubber.

The tendency to scorch and the rate of vulcanisation of rubbers do not appear to be affected appreciably by the method of coagulation; any differences which may exist are not of such a magnitude as to cause the production of abnormal rubbers.

It would seem that the use of excessive quantities of sulphuric acid during the coagulation of the latex may cause some deterioration to the rubber. The sole advantage in using excess would appear to be a reduction of the time needed to complete coagulation. However, the authors of the paper point out, the main reason for the use of sulphuric acid is economic and it does not seem logical that the producer would use more than is necessary and thereby increase his coagulation costs. If the producer were to use four times the normal dosage of sulphuric acid, the material costs would be about twice those for the normal quantity of formic acid.

Pressure dyeing of man-made fibres

A NEW machine which can be used for the pressure dyeing of fabrics made from man-made fibre is reported to have emerged successfully from nearly two years' trial in commercial plants in the United States. The *Barotor* consists, in part, of a huge cylindrical autoclave. Inside is a cage of gleaming rods, looking like a greatly enlarged version of the tiny treadwheel familar to keepers of white mice as pets. Over these rods the full width of the fabric is loosely draped and into the *Barotor* go hot water, wetting agent and dye solution.

The temperature is raised to 250°F. and the cage revolves inside the autoclave at the rate of about two and a half times a minute. With each turn of the cage, the fabric advances a small distance without being under any tension. During the dyeing operation and without interrupting it, operators use a special device to remove samples of the fabric for testing. When dyeing is completed, a scouring solution removes dyeing assistants and the small amount of unfixed colour.

The whole operation, including loading, dyeing, scouring and unloading, takes about 5 hr. The average load is about 1,000 yd. of fabric. While two men are required to operate a *Barotor*, they can run several machines simultaneously without difficulty because of the operating cycle.

The machine has been developed by E. I. du Pont de Nemours & Co. Inc., who report in their magazine that, although used mostly in dyeing fabrics of *Dacron* so far, the *Barotor* and other pressure-dyeing machines are successful with a variety of other fibres, alone or in blends.

Aluminium production in French Guinea

VAST deposits of bauxite have been discovered on the mainland of French Guinea by the Société Africaine de Recherches et d'Etudes pour l'Aluminium, amounting, it is thought, to several hundred million tons. S.A.R.E.P.A., which is partly owned by the French Government and partly by Pechiney & Ugine, the big French aluminium producers, is really interested in aluminium production in French Guinea —not merely bauxite—and have for three years been investigating the possibilities. These investigations are virtually complete.

What is apparently under consideration is the exploitation of bauxite in the Konkoure Basin: the construction of hydroelectric installations, capable of developing 650,000 kw., at Kaleta on the Konkoure River, where the alumina would be converted into metal and brought to Kindia, where a smelter would be built. Thence the aluminium would be railed to Conakry. Annual production of the metal envisaged is between 150,000 and 250,000 tons, the latter figure being much the same as that envisaged for the Volta scheme.

Technically the scheme would appear to be practicable if the electricity necessary for its implementation can be produced cheaply enough. Initial investment needed for this scheme is estimated at £100 million.

Electricity from Fresh and Salt Water—Without Fuel

By R. E. Pattle, M.A. B.SC.

A 'hydroelectric pile' has been developed for producing electricity by making use of the energy released when fresh water and sea water are reversibly mixed. This promises, subject to suitable resin membranes being developed, to lead to a new source of power—cheap, simple and clean in operation. Laboratory experiments that have been carried out and the results achieved so far are discussed in this article, along with the possibilities and problems of large-scale utilisation.

THE new source of power offered by the 'hydroelectric pile' would be particularly suitable for exploitation in those countries with a mild or tropical climate where great rivers flow into the sea, wasting as much free energy as they would if they fell over an unharnessed waterfall 680-ft. high. It so happens that most of these countries lack the ample coal resources of the north temperate zone and in these countries, too, there is less immediate prospect than in some others of atomic energy being successfully developed. These considerations will be touched on later in this article; meanwhile, the principles on which the hydroelectric pile is based will be discussed, the apparatus and the experiments that have been carried out will be described and the considerations entering into further developments will be examined.

Free energy of salt and fresh water; osmotic pressure

If a layer of salt water in a vessel is covered with a layer of fresh water, salt will gradually diffuse up into the fresh water even if the liquids are not stirred. Like many other phenomena which occur spontaneously (for instance the solution of zinc in sulphuric acid, or the exit of air from a cylinder of compressed air), this diffusion can be made to do useful work. In the language of thermodynamics, two separate bodies of fresh and salt water have more 'free energy' than have the same liquids when mixed.

The natural tendency of fresh water to dilute a solution may be manifested in a number of ways. One is the difficulty of drying a garment which has been wetted with sea water. Another is the phenomenon of osmosis, which shows itself when a solution is confined within a membrane permeable to the solvent but not to the solute (a 'semi-permeable membrane'), and pure solvent is allowed access to the outside of the membrane. Solvent then seeps through to dilute the solution inside and can produce a very high pressure within. This seepage is called osmosis; the swelling of dried fruit when placed in water is an example of it. The maximum pressure which can be produced by a solution confined within a semi-permeable membrane is known as the osmotic pressure of the solution.

This phenomenon was studied 40 or more years ago by W. Pfeffer, H. W. Morse, J. C. W. Fraser, Lord Berkeley, E. J. G. Hartley and others.[2] They usually used copper ferrocyanide membranes supported by porous porcelain, and worked with sugar solutions. They did not succeed in finding a membrane permeable to water but impermeable to sodium chloride; but the osmotic pressure of sea water can be calculated from other data, and Y. Mikaye[3] found it to be 20 atm.

Imagine now a cylinder fitted with a piston and filled with a large quantity of sea water, and with its end closed by a membrane permeable to water but not to salt. Let a small quantity of fresh water be allowed access to the outside of the membrane. The fresh water will seep into the cylinder and push the piston back with a pressure of 20 atm., and at the same time the apparatus will be cooled a fraction of a degree. The energy latent in the fresh water and the much larger quantity of sea water is therefore 20 atm. multiplied by the volume of the fresh water. This is equivalent to the energy required to pump the fresh water against a head of 680 ft. (200 m.) of water, or to 2 joules/cc. of fresh water, or to 12.2 h.p. for a flow of 1 gal. of fresh water, per second.

A large amount of energy is thus wasted when a river flows into the sea. (No one, as far as the author is aware, had pointed this out before 1954, although the main facts of osmosis had been known for many decades.) In the case of the Thames, flowing at 2,000 million gal./day, it amounts to about 210 mw., which would require about 1,800 tons/day of coal to generate it. If all this power were abstracted, the river would be cooled by about 0.5°C.

This enormous flow of free energy is continually going to waste. The author therefore looked for some means of utilising it.

Utilisation of free energy

A mechanical device such as the cylinder and piston referred to above is ruled out at once. Even if such a membrane could be made, the seepage of water through it would be so slow as to render the capital cost prohibitive. Other methods can be thought of, based on the fact that water evaporates through a layer of gas or vacuum while salt does not. Any method based on this fact, even if it were not otherwise impracticable, would fail to work, because air, which could not be excluded, would obstruct the diffusion of water vapour.

Mechanical methods seemed therefore to be useless, but the problem of utilising the free energy more easily than does the hydroelectric pile still remains as a challenge to the inventor.

Fortunately for the possibility of utilising the energy, dissolved salt consists, not of neutral molecules like sugar, but of positive sodium ions and negative chlorine ions. If a strong solution of salt is placed in contact with a weak one, the more mobile chlorine ions migrate from the strong solution to the weak, while the migration of the sodium ions is less rapid. The weak solution thus becomes electrically negative. The 'liquid junction potential' thus generated depends on the difference between the mobilities of the two kinds of ion. It is so small

(11 mv. for a tenfold difference in concentration) that no cell based on it could be practical. The ' concentration cell,' which makes use of the fact that an electrode placed in a strong solution has a different potential with respect to the solution than has a similar electrode placed in a weak solution, has a rather larger e.m.f., but would still require non-polarisable electrodes.

With the advent of membranes selectively permeable to one kind of ion—positive or negative—however, the position has been made easier. These membranes have as their essential constituent an insoluble resin of highly basic or acidic character. Consider, for instance, a membrane made from sulphonated cross-linked polystyrene. This consists of a network of styrene molecules with sulphonic acid groups fixed at various points in the network.

These acid groups form part of the substance of the membrane and therefore cannot move. But the hydrogen or metal atoms which are associated with them are mobile ions. The membrane may therefore be visualised as a giant molecule of an acid or salt which is insoluble but can be ionised to give one very large non-mobile negative ion and a large number of mobile positive ions.

It can be shown that the presence of the fixed negative charges in the membrane will tend to prevent mobile negative ions (for instance chlorine ions) from wandering into the membrane from the solution in which it is immersed. With recently developed cation-selective membranes, negative ions from outside are almost completely excluded.

If a membrane of this kind is placed between a strong and a weak solution of sodium chloride, more positive ions will pass through it from the strong to the weak than in the opposite direction, and this process will go on until a sufficient positive potential difference is built up to prevent any more ions from crossing. The weak solution will therefore become positive with respect to the strong.

The theoretical difference of potential for a tenfold change in concentration across the membrane is (RT/F) *ln* 10, or 58 mv., where R is the gas constant, T the absolute temperature and F Faraday's constant.

In an exactly analogous way it is possible to make a ' basic ' membrane permeable only to negative ions. If such a membrane is placed between a weak and a strong solution of salt, the weak becomes negative with respect to the strong.

Principle of hydroelectric pile

The e.m.f. generated by a single membrane would not be enough to overcome the polarisation potential at, for instance, a pair of carbon electrodes; in the hydroelectric pile, however, a special arrangement is used. If a number of membranes and solutions are arranged as shown in Fig. 1, the e.m.f.s produced by individual membranes can be placed in series and a useful voltage produced.

Thus, compartment 2 contains fresh water, and is separated by an acidic (sodium ion permeable) membrane from compartment 1, which contains an electrode and salt water. Sodium ions can therefore pass from compartment 1 to compartment 2, making 2 electrically positive with respect to 1. Chlorine ions will likewise pass through the basic membrane *B*, so that compartment 3 will become positive with respect to 2. Compartment 4 will be still more positive, and so on. The pile may contain any number of membranes, each of which can be made to generate between 40 and 60 mv. Any desired voltage can thus be built up, and the polarisation voltages at the electrodes can be overcome.

If current is drawn off from the electrodes in the end compartments of the pile, positive and negative ions will pass through the appropriate membranes from the strong to the weak solutions. The latter will thus become more salt, and the former less salt. This will lower the e.m.f. of the pile. In order to prevent the e.m.f. from steadily declining, salt water and fresh water can be continuously supplied to the alternate spaces in the pile, so that the water in them remains salt or relatively fresh. The pile is not likely to be of practical use unless naturally occurring solutions, such as sea water and river water, are used. Although in the illustration discussed above the compartments have been described as containing strong and weak solutions of salt, other solutions of different strengths could be used instead.

Optimum concentration of salt

There is an optimum concentration of salt in the fresh-water spaces for which the power output of a given pile will be a maximum, and this concentration can be maintained by regulating the flow of fresh water into the fresh-water spaces. The way in which there comes to be such an optimum concentration will now be explained. When the water in the fresh-water spaces contains very little salt, the e.m.f. of the pile will be high, owing to the wide difference of concentration across the membranes. But the resistance of the fresh water, and thus the internal resistance of the pile, will also be high, and so the power output will be low. When the fresh-water spaces contain too much salt, the resistance will be low, but the e.m.f. will be very low. Between these two extremes there is a salinity which enables the pile to give its maximum output, with neither too high a resistance nor too low an e.m.f. The precise value of the optimum salinity in the fresh-water spaces depends on the details of the construction of the pile, but is usually about one-tenth of that of sea water.

A fact which will have an important bearing on the construction of piles for large-scale use is that the free energy lost on mixing fresh water with sea water is much more if the fresh water is completely fresh than if it contains a small amount of salt. Half the free-energy loss takes place when only one-fifth of the salt has been

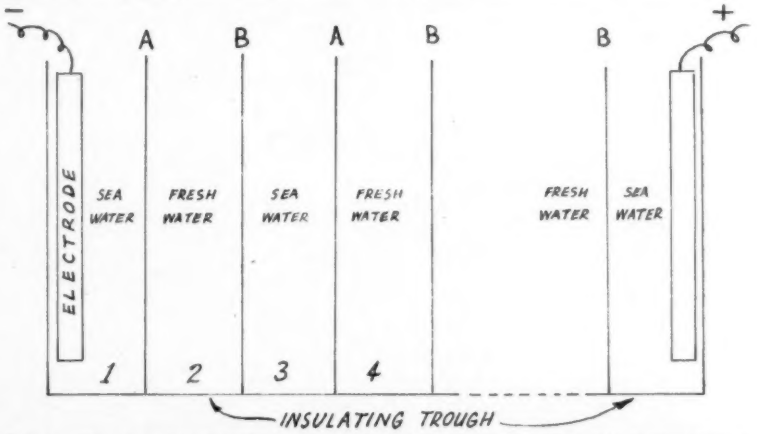

Fig. 1. Diagram showing the arrangement of the membranes in the hydroelectric pile. Letters denote (A) acidic and (B) basic membranes.

transferred. The e.m.f. and power output of the pile fall off steeply as the salinity in the fresh-water space is raised above this value. This means that it will probably not be economical, for reasons of capital cost, to try to extract more than half the free energy of fresh water. In order, too, to reduce capital costs to a minimum, the pile would probably be run so as to give a maximum output of external power. This would mean that the external impedance connected across the terminals would have to be equal to the internal impedance of the pile, so that half the power actually produced was dissipated inside the pile. An external power output of about a quarter of the free energy of the liquids supplied seems therefore to be a possible target value for the pile's efficiency. This power output would be equivalent to that of a water turbine supplied with the same flow of water as the pile and utilising a head of 170 ft. (50 m.).

The actual arrangement of the flow through the pile, so as to avoid stagnant areas in the water compartments and to maintain an e.m.f. uniform over the whole cross-section of the pile, is a matter for further experiment.

Description of model pile

A model pile was assembled at the Chemical Research Laboratory of the D.S.I.R. at Teddington and, by courtesy of the Director, the author has been able to carry out some experiments with it. The first of these have already been briefly reported.[1] The pile consists of a number (at present, 89) membranes, with 88 compartments between them. Each compartment is about 8-cm. square and 0.7-mm. thick. The membranes are about 0.7-mm. thick and the total length of the pile between the end membranes is 14 cm. The pile is clamped together by two *Perspex* end-pieces which are joined by screwed brass rods. At the ends of the pile, between the end membranes and the *Perspex*, are two spaces filled with copper sulphate solution and fitted with copper electrodes. These non-polarisable electrodes have the sole purpose of enabling accurate measurements of e.m.f. to be made; the pile would still give current if polarisable electrodes, such as carbon or magnetite, were used.

The membranes are kept apart by strips of cardboard soaked in vaseline; these also form the top, bottom and sides of each compartment. By means of a complicated system of holes and washers, fresh and salt water are supplied to alternate spaces between the membranes. The flow system is still being developed and will not be described here; suffice to say that among the troubles encountered have been leaks (those from salt to fresh being especially pernicious), air locks and the tedious nature of the assembly process.

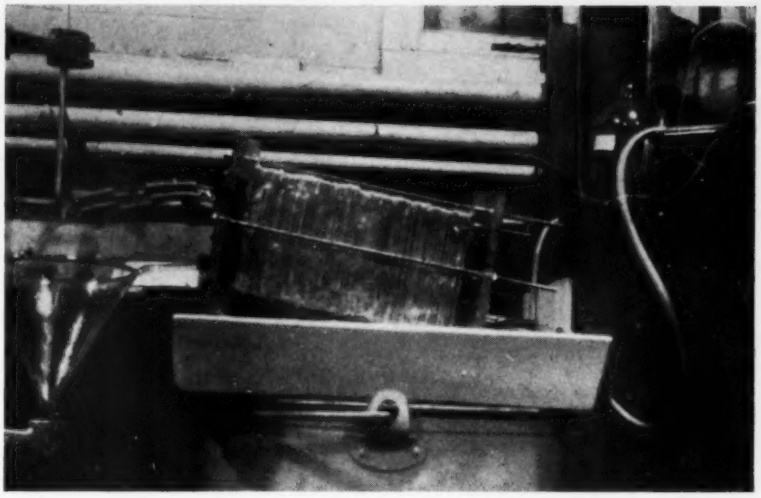

Fig. 2. The model pile shown in operation in the laboratory.

The liquid supplied to the salt-water spaces has been 0.5 N sodium chloride solution (representing sea water). De-ionised water or tap water has been supplied to the fresh-water spaces. The maximum e.m.f. has been 6.6 v. (or 74 mv. per membrane). The maximum external power output has been 44 mw. This was achieved when the pile has been warmed to 33°C. At room temperature the power obtainable was 30 mw. This change in power output with temperature is very important, as will be explained later.

Fig. 2 shows the model pile in operation. Water is fed in at the bottom at one end and makes its exit at the top of the other end. The *Perspex* end-pieces, between which the membranes are clamped, can be clearly seen.

Over a period of four months, the pile ran quite satisfactorily, though at a power output lower than its maximum. It was then reassembled, and it was found that the membranes had in no way deteriorated during their contact with the liquids.

Membranes

The maximum power output of the model pile was about 50 w./cu.m. The membranes used were composite membranes (presented by B.X. Plastics Ltd.) and consisted of finely powdered ion-exchange resins bound together with a matrix of polyethylene. Current therefore had to cross the membrane *via* the contacts between the resin granules. Although these contacts improve with time, as the resin granules swell, the resistance of a composite membrane of this kind is bound to be much higher than that of a membrane composed of ion-exchange membrane alone.

The maximum external power output of a pile of given e.m.f. and volume is inversely proportional to its resistance, so that in order to improve the power output per unit volume of pile, membranes of lower resistance are needed. A lower resistance will be found in a pure resin membrane than in a composite one, and the thinner the membrane is the lower will be its resistance. A thin membrane will have another great advantage over a thicker one, in that it will contain less resin and will be cheaper. More membranes can also be packed in a given space if they are thin, and a greater e.m.f. per unit length of pile can thus be obtained. For instance, a pile with water spaces 1 mm. across and pure resin membranes 1-mm. thick would contain about 250 kg. of each kind of resin per cubic metre, while if the membranes are only 0.25-mm. thick a cubic metre of pile would contain only 100 kg. of resin and would also have an e.m.f. 60% greater.

To get the maximum power output from the pile, then, a membrane of pure resin will be necessary; and, within limits (at present unknown) set by the diffusion of salt across it in the absence of current, the thinner it is the better. Among the ion-exchange

resins which have sufficient exchange capacity to be used in the pile are those formed from phenol-sulphonic acid and formaldehyde and those formed from sulphonated polystyrene. These resins tend to be somewhat brittle, but it is possible to spread them on a backing of cloth. In theory at least only a thin smear of resin is necessary to give good permselectivity. Research is needed on a continuous process in which a layer of resin in liquid form is smeared on a strip of backing material, or between two strips of it, and is then polymerised and cross-linked to the required degree.

In theory, if the membranes and water spaces can be made thin enough, there is no limit to the power output per cubic metre; but as the water spaces are made thinner, the pressure drops required to circulate the liquids rise. If the membranes could be made so thin that their resistance were negligible (as would be the case with a membrane 0.1-mm. thick), the greater part of the pile's resistance would lie in the fresh-water spaces. With water spaces 0.75-mm. thick, the maximum power output would be developed with a salinity in the fresh spaces about one-tenth that of sea water; 1 cu. m. of such a pile would have a maximum external power output of 1.2 kw. at 25°C. It would contain about 45 kg. of each kind of resin.

Large-scale possibilities and problems

Given suitable membranes, then, the pile may well be an economic source of power, if only it can be kept running for a sufficiently long time before it needs cleaning out or its membranes need renewing. There are two possibilities of long-term trouble. One is chemical change in the membranes. It is possible that polyvalent ions present in sea water might accumulate in them and damage their permselectivity. In the model pile, however, no change has been observed over a year's operation with sodium chloride solution prepared with tap water. The other possible trouble is fouling by silt and micro-organisms. The model pile has so far kept free from this trouble, but this may be due to the copper sulphate used in the electrode compartments. The amount of fouling which would occur would, of course, vary with local conditions, and this is a subject on which research, carried out with even a dummy pile in any part of the world, would be of great value.

The hydroelectric pile is in some ways similar to the apparatus used for electric desalting of water. Work on the latter subject is bound to produce a good deal of know-how relevant to the hydroelectric pile. In some ways, however, the requirements for the hydroelectric pile are more stringent; in particular, desalting of brackish water (as opposed to sea water) can be carried out using membranes of less ion-exchange capacity than those which are necessary for the pile.

Stagnant areas in a de-salter would probably be less important than similar areas in a pile, as in the former case current will prefer to flow where it is most needed, *i.e.* where the space being desalted is most salt.

The pile also bears some resemblance to a four-compartment secondary cell (the 'membrane accumulator') described by Dr. G. Manecke of Berlin.[4]

Effect of climate

There remains one very important operating characteristic of the pile. This is the variation with temperature of its maximum power output. This is mainly due to the variation of internal resistance with temperature, and will amount to about 3% per °C. For operation in a temperate climate, such as that of Britain, this is a most serious disadvantage, as the pile output will be least when electricity is most needed, *i.e.* in the coldest part of the winter. In countries such as Canada, with a severe winter, the pile has few prospects; in freezing weather it would have to be flooded with salt water, or drained completely, to avoid damage to the membranes.

In warmer climates, such as those of India and Burma, however, there may be less of a peak load in the cold season. The output of the pile will fluctuate with the temperature, and with the amount of water available; but it will on the whole be higher than in a temperate climate, and will not be faced with a large space-heating load. In particular, truly tropical climates, such as those of Indonesia and the Belgian Congo, with ample rainfall and continuous warmth, would be favourable to an economic use of the pile. It so happens that those countries with ample coal resources have least prospect of using the pile economically, and that where the pile would be most useful coal resources are scanty.

As a source of power the pile has the obvious advantage over the steam or oil-fired turbine that it has no moving parts and produces no ash. A certain amount of chlorine would be produced at the pile's anode; this could be collected for industrial use, or else used to prevent pollution of the pile by organisms. Apart from this, the pile could not cause atmospheric pollution, which is a major nuisance from coal- or oil-fired installations. Apparatus would be needed to convert the direct current produced by the pile into alternating current for distribution, and a certain amount of pumping machinery would probably be necessary.

Conclusion

The main novel source of power in the world today is atomic energy. It appears that, after vast expenditure on research and development, the time is near when electric power will be generated economically from uranium. But from the point of view of an undeveloped country an atomic energy plant has one disadvantage—it requires scientific and engineering supervision of the most advanced character and, if mishandled, can be a source of considerable danger. It is unlikely that an undeveloped country could provide a labour force capable of operating an atomic power station. The hydroelectric pile, however, once installed, would be simple to operate; the amount of machinery would be less than in an ordinary power station; and the pile could never in any way be harmful to anyone. It cannot even be damaged (as can an ordinary battery or dynamo) by short-circuiting the terminals—all that happens is that the liquids leave the pile at the temperature at which they went in, instead of being cooled a fraction of a degree.

To sum up, the hydroelectric pile is now in a position similar to that of the gas turbine before the discovery of the Nimonic series of alloys. The model pile fulfils all that was expected of it, but its economic use must await the development of a suitable membrane.

Acknowledgment

This article is published with the approval of the National Research Development Corporation, the owners of the British Patent application 1939/53. The author is solely responsible for the opinions expressed in the article.

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OZONE

I. Properties and Manufacture

By D. J. Saxby, B.SC., F.R.I.C.
(Chief of Research, Tack Air Conditioning Ltd.)

Increasing use of ozone for a number of purposes in chemical and food factories, waterworks and other industries has created a demand for more information about this versatile gas. Here is the first part of an article in which its properties, manufacture and uses are surveyed.

THE first reference to ozone occurs in the 18th century when it was noticed that a peculiar smell was produced in the vicinity of electrical machines. In 1782 Cavello noticed that this electrified air or 'aura electrica,' as he called it, destroyed the smell of putrescent vegetable and animal matter and he therefore recommended its use as a disinfectant.

In 1785 W. Van Marum also noticed that a distinct odour, which acted on mercury, was produced by electrical machines, but he made no attempt to discover the cause of the smell. It was thought that the smell was due to the effect of electricity on the olfactory nerves and this belief persisted until 1840, when Schönbein was struck by the similarity between the smell produced by an electrical machine and that obtained when dilute sulphuric acid was electrolysed. He came to the conclusion that the two smells were identical and that they were caused, not by electricity, but by a definite chemical compound which he called ozone (from ὀζω—I smell).

De la Rue and Marignac subsequently produced ozone by passing an electric spark through clean, dry oxygen, and were able to prove that ozone was a modified form of oxygen.

It was found that ozone could be produced in many ways, but only two methods were of practical value, *viz.* the electrolysis of dilute sulphuric acid and the passage of air or oxygen through an electrical discharge. Electrolysis was difficult to control and was little used, but during the last 70 or 80 years a great variety of electrical discharge-type ozonisers have been designed; many of them were unsatisfactory, either because of lack of suitable insulating and electrode materials or because of ignorance of basic principles. However, difficulties such as these have now been overcome and today efficient and reliable ozonisers of all sizes are available.

The remarkable oxidising power of ozone was recognised at an early date and for many years ozone has been used for water sterilisation, effluent treatment, air purification, dental and medical treatment and as an oxidising agent in chemical industry.

In this article we shall describe the occurrence and properties of ozone and discuss its manufacture and practical applications.

Occurrence of ozone

It has already been indicated that ozone is an allotrope of oxygen and it might be expected that it would be a normal constituent of the atmosphere. This is, in fact, the case, although figures of several parts per million quoted by early writers are quite erroneous.

Fresh air, such as occurs at the sea side, in mountainous districts and at other places where industrial and organic contamination is absent, may contain a few parts of ozone per hundred million parts of air. Ozone is completely absent from the air of towns and cities.

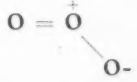
At one time it was thought that the blue colour of the sky was due to ozone. This idea has now been disproved, but there is little doubt that a layer of ozone, probably produced by ionising radiations from outer space, exists in the stratosphere at a height of about 20 km. Ozone shows strong absorption bands in the ultra-violet and infra-red regions of the spectrum and, in consequence, the layer of ozone in the stratosphere is of some importance, because it not only absorbs harmful radiations below 3,000°A. but also helps to prevent loss of radiant heat from the earth's surface.[1] But for this layer of ozone it is doubtful if life, at any rate in its present form, could exist on the earth.

Properties

Ozone (O_3, mol. wt. 48) condenses to a dark blue, unstable liquid at -122°C. and freezes at -201°C. It is slightly soluble in water, but, as decomposition occurs, the solubility can only be determined indirectly. Rothmund and Burgstatter give 0.494 as the solubility coefficient at 0°C.

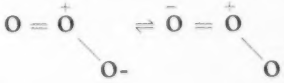
Several formulae have been proposed for ozone, but absorption spectra measurements show that it must have either a ring

or bent chain



structure.

The bent chain with resonance between two forms is most probable:



The outstanding properties of ozone are its characteristic smell, which is detectable at very low concentrations, and its remarkable oxidising power. Ingols[2] quotes a figure of 2.5 for the oxidation-reduction potential of ozone as compared with 1.3 for chlorine.

Ozone is an unstable gas which, even in the absence of oxidisable material, decomposes spontaneously; hence it cannot be stored.

In the absence of water vapour, catalysts and oxidisable material, Warburg found that the decomposition was bimolecular, *i.e.*

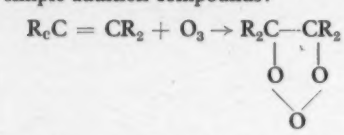
$$2O_3 \longrightarrow 3O_2.$$

Ewell[3] found that, when, as usually occurs in practice, oxidisable matter is present, the reaction is monomolecular and the bimolecular reaction can be neglected:

$$O_3 \rightleftharpoons O_2 + O$$

Ozone reacts with many organic and some inorganic compounds. With unsaturated hydrocarbons in the

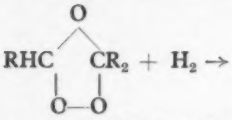
absence of water, ozonides are formed and Harries[4] thought that these were simple addition compounds:



Briner was unable to reproduce Harries' results and the validity of the addition theory is questionable. According to Staudinger,[5, 6] the first product of the reaction is a molozonide; this is unstable, but can become stable in one of two ways: (*a*) by forming an iso-ozonide by internal rearrangement or (*b*) by polymerising to a compound of higher molecular weight. The accompanying diagram illustrates the mechanism suggested by Staudinger.

Staudinger's theory has not been completely proved, but there is much in its favour; for instance, according to the iso-ozonide formula, the carbon chain has already been broken and this explains many of the reactions of ozonides. His theory also accounts for the fact that some ozonides are unstable and others are relatively stable.

The majority of ozonides are viscous explosive liquids with a powerful odour. They are reduced by hydrogen to aldehydes and ketones:



$$R.CHO + R.CO.R + H_2O$$

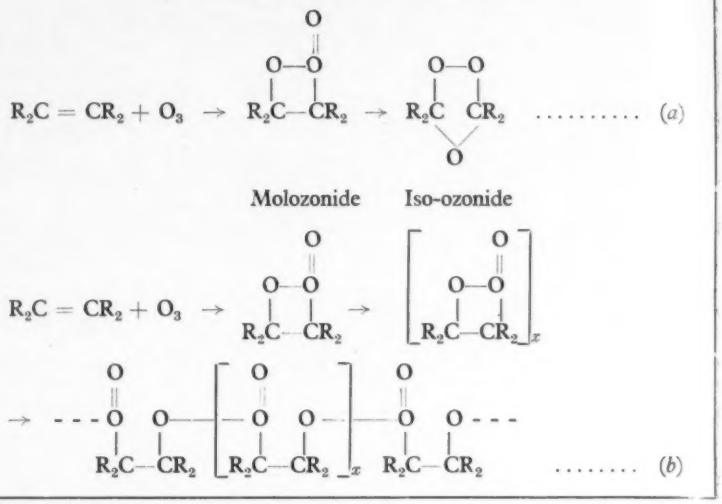
Reaction with water produces a mixture of aldehydes, ketones, acids and hydrogen peroxide. Benzene forms the triozonide, which is explosive and reacts with water to give glyoxal.

Other reactions of ozone of technical importance will be considered later.

Starch iodide papers are frequently used for detecting ozone, although they are, in fact, less sensitive than the nose. They can be used for semi-quantitative work, providing the ozone concentration is not lower than about 0.3 p.p.m.

Many methods have been proposed for the quantitative estimation of ozone, but for many purposes the most convenient is a modification of the classical method which depends on the liberation of iodine from potassium iodide solution. This method gives good results providing precautions are taken to avoid errors caused by loss of iodine and the formation of side-products. A fact which is not always recognised is that the reaction of ozone with potassium iodide is extraordinarily rapid and, in consequence, complete absorption of ozone can be obtained at very high rates of gas flow. This is a great advantage when the concentration of ozone is low and a large volume of air has to be sampled.

Reactions Illustrating Staudinger's Theory



Toxicity

The use of ozone in air purification and water treatment will be discussed later, but it may be mentioned in passing that ozone, both in aqueous solution and in gaseous form, has pronounced bactericidal, fungicidal and viricidal properties.

Ozone has no insecticidal value and many insects thrive in concentrations of ozone which would be lethal or at least very irritating to mammals.

Little is known about the effect of ozone on animals, but it has been reported that some animals and birds are more active and reproduce more prolifically when exposed to rather higher concentrations of ozone than could be tolerated with comfort by human beings.

The subject of the toxicity of ozone to human beings is a complicated one. Not only are some individuals more sensitive to ozone than others, but ozone generated by poorly designed apparatus may contain oxides of nitrogen which are considerably more toxic than ozone. This probably accounts for the widely differing statements which have appeared in the literature of the subject. It should be emphasised here that ozone has a characteristically pungent odour which indicates when high concentrations are present and nobody would voluntarily remain in a room where the ozone concentration was sufficiently high to be dangerous. The experience of the writer, gained over a number of years, is that exposure to fairly high concentrations of ozone which cause considerable temporary discomfort does not result in any permanent harm. In other words, ozone becomes intolerable long before it becomes dangerous.

Table 1 gives some idea of the effect of various concentrations of ozone on human beings.

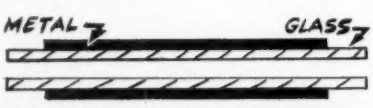


Fig. 1. Diagram showing principle of ozone generation by electrical discharge.

Manufacture of ozone

There are many ways of producing small quantities of ozone, for example by heating oxygen to very high temperatures, by slow oxidation of phosphorus, by heating Mn_2O_3 and by passing gaseous fluorine through water, but, at least until a few years ago, all commercial methods depended on the passage of air or oxygen through an electrical discharge.

Ultra-violet light of 1,850Å also produces small quantities of ozone. Radiation of this wavelength is produced by low-pressure mercury discharge tubes. Ordinary glass completely absorbs short-wave ultra-violet light and at one time it was necessary to use a discharge tube with a quartz envelope, but special glasses with good

Table I. Effect of Various Concentrations of Ozone on Human Beings

Concentration (p.p.m. by vol.)	*Symptoms*
0.01	Threshold of odour.
0.02	Perceptible on entering room but not noticed after a few minutes' exposure.
0.04	Perceptible. Not unpleasant.
0.10	Objectionable to most persons. Often some irritation of nose and throat.
1.00	Very strong odour. Prolonged exposure produces thickening of mucous, headache and sleeplessness. The symptoms often persist for some hours after leaving the ozonised atmosphere.
3.00	Intolerable. Symptoms appear in a few minutes.

transmission in the short-wave region have now been developed and, in consequence, the cost of suitable lamps has been considerably reduced. The lamps must, of course, be shielded, in order to protect the eyes from the dangerous effects of short-wave radiation. Ozone lamps of this type are used, particularly in the United States, for deodorisation in small spaces such as kitchens and domestic refrigerators. They normally generate only a few milligrams of ozone per hour and are hardly suitable for producing large amounts of ozone.

We mentioned earlier that ozone is produced during the electrolysis of dilute sulphuric acid. It appears, of course, at the anode, the reaction being

$$3H_2O \rightarrow 6\dot{H} + O_3 + 6e$$

Attempts to use this process on a commercial scale have been unsuccessful, because it is difficult to control and the ozone yield is rather low.

However, dilute sulphuric acid is not the only solution which gives rise to ozone when it is electrolysed. In 1935 Koehler[7] reported that traces of ozone were produced by the electrolysis of perchlorates and in 1940 Putnam *et al.*[8] published an account of the preparation of ozone by the electrolysis of perchloric acid. Perchloric acid, 40%, cooled to -50°C., was electrolysed, using platinum anodes and lead cathodes, separated by a glass-cloth diaphragm. Yields of 10 g./kwh. or more at concentrations of over 20% were obtained and the method seems to show some promise for the production of high concentrations of ozone. As far as the writer is aware, the method has not yet been used on a large scale.

Electrical discharge method of ozone manufacture

The last and most important method which we have to consider is the generation of ozone by an electrical discharge. The principle underlying the method is very simple and may be demonstrated as follows. A simple ozonising element is shown diagrammatically in Fig. 1. Two parallel glass plates, backed with somewhat smaller metal plates, are separated by an air gap of a few millimetres. When a high-voltage alternating potential is applied across the metal plates, a faint hissing noise is heard and a bluish-violet glow fills the space between the plates. This bluish glow is the glow or so-called silent discharge, but it is, in fact, always accompanied by a hissing or crackling noise.

It should be noted that the plate of glass or other dielectric material is there to prevent the glow discharge degenerating into an unstable arc or spark discharge. So far as ozone production is concerned, it is a necessary evil and efficiencies would be considerably higher if it could be eliminated. This fact was recognised, even in the early days of ozone manufacture, and several unsuccessful attempts were made to prevent an arc discharge by other means.

Plate-type ozonisers, such as we have described, are used to a limited extent, but tubular ozonisers, for reasons which will be discussed later, are often to be preferred.

Large quantities of ozone are used for water purification and effluent treatment, while air conditioning and cold storage are among other principal industrial uses. In the chemical industry, also, there is increased interest in ozone as an oxidising agent, especially in the United States. Part 2 of this article —which will be fully illustrated—will briefly discuss these uses, along with the various types and sizes of ozone generators that are used.

A tubular ozoniser consists essentially of two concentric glass tubes, the inner surface of the smaller tube and the outer surface of the larger tube being coated with electrically conducting material. When a high alternating voltage is applied across the conducting coatings, a glow discharge is produced in the annular space between the two tubes. There are, of course, many variations of the simple tubular ozoniser; for example, one of the glass tubes may be replaced by a metal tube or the outer glass tube may be immersed in a conducting liquid such as dilute sulphuric acid, which serves not only as a cooling agent but also as an outer electrode.

All commercial ozonisers depend on the electrical discharge for the generation of ozone, although their design may differ somewhat according to the purpose for which they are to be used. Ozonisers for specific purposes will be dealt with later and we shall confine ourselves here to a brief discussion of the formation of ozone by the electrical discharge.

The exact mechanism of ozone formation is not known with certainty, but the reaction, which is strongly endothermic, probably follows the course:

$$O_2 \rightleftharpoons 2O$$
$$2O + 2O_2 \rightleftharpoons 2O_3$$

the net result being $3O_2 \rightleftharpoons 2O_3$.

Even under the most favourable conditions the reaction does not proceed very far to the right-hand side. It follows that, under static conditions, *i.e.* with no airflow through the ozoniser, the ozone concentration eventually reaches an equilibrium value which depends on the prevailing conditions and on the design of the ozoniser. For example, if an ozoniser is operated in a small closed chamber, the ozone concentration will rise to a certain value and then become constant, no matter how long the ozoniser is operated. A change in conditions, such as an increase in voltage, will, of course, increase the ozone concentration, which will eventually reach a constant but higher value than before.

The yield of ozone is seriously diminished by water vapour. This fact is usually ignored in air-conditioning-type ozonisers, because the large volumes of air which have to be handled make an air drier impracticable and it is usually very much cheaper to install a somewhat larger ozoniser in the first place. On the other hand, industrial ozonisers must be supplied with dry air; not only is

(*Concluded on page* 366)

A Small-Capacity Equilibrium Still

By S. R. M. Ellis, PH.D., F.R.I.C., A.M.I.CHEM.E. and J. M. Thwaites, B.SC.
(Department of Chemical Engineering, University of Birmingham)

An equilibrium still of only 40-cc. capacity has been used to obtain vapour-liquid equilibrium data for two binary systems, and surprisingly good results have been obtained. The still and the experimental results have been discussed in the 'Birmingham University Chemical Engineer' recently, and this article is reproduced below.

RELIABLE vapour-liquid equilibrium data are essential for the design and operation of distillation and similar equipment and in recent years a considerable number of equilibrium stills of various types has been proposed for the accurate experimental determination of such data. The majority of these stills require between 250 cc. and 500 cc. of mixture for each individual determination, so that in obtaining a complete equilibrium curve large amounts of the pure components are required. It is often impracticable to carry out experimental work in these circumstances, either because only comparatively small amounts of the components are available, or in some cases because the cost of large quantities would be excessive, and a need exists for an apparatus which will permit the determination of reliable data while using relatively small amounts of the pure components.

An equilibrium still requiring a charge of 100 cc. was designed by Ellis[2] for use with relatively low boiling organic mixtures, but this is not particularly suitable for systems which have a tendency to boil unevenly, such as certain aqueous mixtures. Furthermore, sampling is difficult while the still is in operation.

An equilibrium still has therefore been designed which has a total capacity of only about 40 cc.

Because of the small size of the apparatus it was thought likely that the still would give results which, while of sufficient accuracy for practical design purposes, might not correlate as accurately as data obtained with a larger still.

Apparatus

The details of the still, which is illustrated in Fig. 1, are as follows:

The mixture is boiled in the bayonet-type double-walled heating unit *B*. The clearance between the walls of this unit is about 1 mm. Experience with various types of heating units for equilibrium stills has shown that this type of heater gives the smoothest boiling conditions, provided that the clearance between the walls is very small. This is particularly important when certain systems containing water and some other inorganic liquids are involved. The heat input is provided by an electric heater inserted into the centre of the boiling unit.

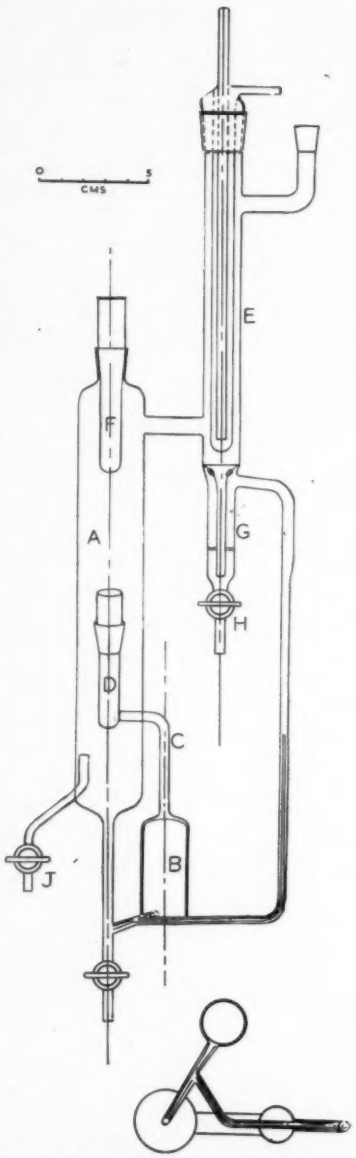


Fig. 1. Elevation and plan of the still described in this article.

Table 1. Results for System Ethyl Alcohol-Benzene

t(°C.)	Mol % ethyl alcohol		Activity coefficient	
	Liquid	Vapour	Log γ_E	Log γ_B
76.8	1.5	11.7	—	—
75.25	2.5	16.3	0.758	—
73.4	5.2	21.7	0.703	0.009
71.6	7.8	27.9	0.668	0.010
70.0	13.5	33.5	0.538	0.029
68.75	22.3	39.3	0.420	0.053
68.2	30.0	41.7	0.328	0.090
67.9	40.0	44.3	0.235	0.138
67.95	60.3	48.2	0.092	0.286
68.25	66.9	49.8	0.055	0.346
70.5	84.3	63.3	0.015	0.501
72.3	90.2	71.4	0.006	0.571
72.85	91.4	74.3	0.005	0.580
75.05	95.6	84.2	—	0.623
77.4	99.2	95.8	—	—

Table 2. Ethyl Alcohol-Benzene Theoretical Activity Coefficients (Margules)

Mol. % ethyl alcohol (liquid)		Log γ_E	Log γ_B
10	—	0.628	0.009
20	—	0.479	0.037
30	$A = 0.816$	0.346	0.079
40	—	0.248	0.140
60	—	0.097	0.283
70	$B = 0.655$	0.053	0.361
80	—	0.025	0.461
90	—	0.013	0.559

The mixture of vapour and boiling liquid passes up the equilibrium tube *C* and impinges directly on to the thermometer pocket *D* which measures the liquid boiling temperature.

The vapour passes upwards through

the main body of the still *A* and thence to the condenser *E*. A thermometer pocket *F*, in the vapour stream, measures the temperature of this vapour.

The condensed vapour collects in the receiver *G* and recirculates through a capillary tube to the boiler. Samples of vapour and liquid are withdrawn from taps *H* and *J*. In order to obtain as nearly as possible a sample of the liquid which has just impinged on the thermometer pocket, the inlet to tap *J* is situated just below the surface of the liquid and immediately below the thermometer pocket.

The whole still was lagged before use with a layer of magnesia-asbestos on top of a thin layer of asbestos paper. Before lagging, an external heater was wound round the upper part of the still. The purpose of this is to maintain the vapour at a slightly higher temperature than the observed boiling point in order to prevent any fractionation of the vapour before it reaches the condenser.

In operating the still a boiling rate of from 15 to 30 drops/min. is maintained, according to the mixture being boiled. It is thought that equilibrium is probably attained in 20 to 30 min., but the still is allowed to boil for 1½ to 2 hr. before samples are taken.

All temperature measurements are made with accurate mercury-in-glass thermometers which can be read to $\frac{1}{10}$°C. Temperatures are corrected for variations in atmospheric pressure.

Experimental results

Results have been obtained with the miniature equilibrium still for two binary systems, ethyl alcohol-benzene and *n*-propyl alcohol-water. The former was chosen because of its general suitability as a system for testing the accuracy of an equilibrium still and because it has been shown that accurate data for this system can be obtained using a still of normal size.[3] The *n*-propyl alcohol-water system was selected mainly in order to show whether smooth boiling conditions, and therefore accurate results, could be obtained for a system which was likely to produce uneven boiling. Both these systems may be analysed rapidly and accurately by means of refractive index measurements, though it was necessary to carry out the analysis of a number of the *n*-propyl alcohol-water results by density measurements.

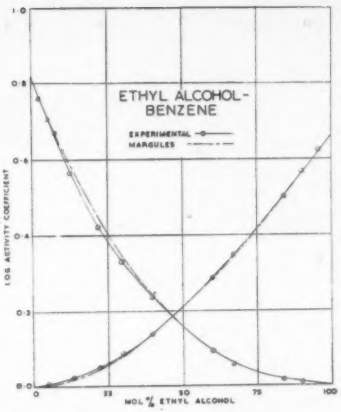


Fig. 2. Experimental and theoretical plots for the system ethyl alcohol-benzene.

SYMBOLS

A = Log end value of the activity coefficient of component 1 at infinite dilution in component 2.
B = Log end value of the activity coefficient of component 2 at infinite dilution in component 1.
t = Boiling point in °C.
T = Boiling point in °A.
γ = Activity coefficient.

For both systems comparisons have been made between experimental and theoretical plots of activity coefficients to judge the accuracy and consistency of the experimental results. The Li-Coull[5] correlation has also been applied as a further test of the accuracy of the results.

Ethyl alcohol-benzene

The experimental results and activity coefficient data for this system are shown in Table 1.

The experimental activity coefficient data from Table 1 have been plotted against composition in Fig. 2, which indicates the general consistency of the experimental results.

For a system such as this, in which an azeotrope is formed, it is possible to calculate the *A* and *B* values for the system from the experimental azeotropic data using a rearranged form of the van Laar equations.[1]

The values obtained, $A = 0.816$ and $B = 0.655$, agree exactly with the values obtained from the experimental activity coefficient curves, indicating that there is agreement between the predicted van Laar and experimental data. From these values of *A* and *B* theoretical activity coefficients have been calculated using the Margules three-suffix equation. These are given in Table 2.

The activity coefficients from Table 2 have also been plotted in Fig. 2. Comparison of the two plots shows fair agreement between the experimental and predicted data which indicates reasonable accuracy of the experimental results.

Fig. 3 is a plot of $(T \log \gamma)^{-0.5}$ against a ratio of the liquid compositions of the components. This is a method of correlation proposed by Li and Coull[5] which should give straight lines for accurate experimental data. The data in this case conforms well with this requirement.

As a further check on the accuracy of the results the Hall[4] correlation has been applied. For accurate data the ratio of the mean values of $(T \log \gamma)^{-0.5}$ at composition ratios 0 and 1 should

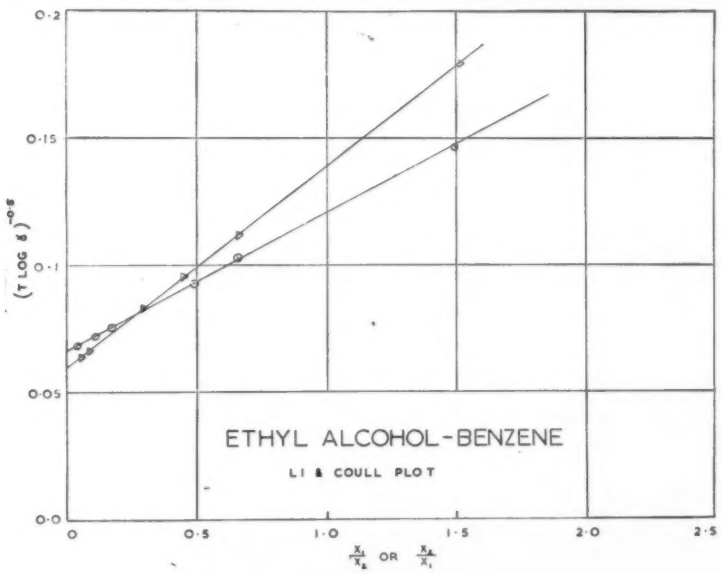


Fig. 3.

Table 3. Experimental Results, *n*-propyl Alcohol-Water

t(°C.)	*Mol %* propyl alcohol		*Activity* coefficients	
	Liquid	*Vapour*	*Log* γ_P	*Log* γ_W
98.7	0.3	4.8	—	—
96.4	0.9	13.0	1.172	0.0004
93.4	1.0	23.1	1.14	0.001
91.45	3.1	28.5	1.054	0.007
89.6	5.0	34.5	0.955	0.009
88.75	6.7	36.7	0.879	0.013
88.4	9.4	38.0	0.748	0.022
87.9	19.2	39.5	0.483	0.070
87.8	28.0	40.8	0.339	0.112
87.85	50.9	43.2	0.101	0.260
87.9	52.0	44.1	0.099	0.262
89.0	72.5	56.3	0.024	0.378
90.4	81.6	64.7	0.011	0.435
91.5	86.2	70.8	0.006	0.460
93.5	93.0	82.5	0.003	0.496
95.4	97.0	91.6	0.001	0.519

Table 4. *n*-Propyl Alcohol-Water Theoretical Activity Coefficients (van Laar)

Mol. % propyl alcohol (liquid)		*Log* γ_P	*Log* γ_W
10	—	0.752	0.0202
20	—	0.488	0.066
30	$A = 1.18$	0.313	0.124
40	—	0.194	0.188
50	—	0.115	0.251
60	$B = 0.535$	0.064	0.313
70	—	0.032	0.374
80	—	0.0124	0.430
90	—	—	0.486

equal 2. The experimental results give a value of 2.02.

These tests all indicate that the results obtained from the miniature still for the system ethyl alcohol-water are satisfactory.

Results for system *n*-propyl alcohol-water

It has been found that the *n*-propyl alcohol-water system tends to produce very uneven boiling conditions in the concentration range from 0 to about 15% *n*-propyl alcohol. This is probably due to the large change in boiling points produced by small differences in composition over this range. The miniature still, however, gives reasonably smooth boiling for mixtures in this region and for the rest of the system gives very even boiling.

The experimental results for this system are given in Table 3.

The values of A and B calculated from the azeotropic data, $A = 1.17$ and $B = 0.533$, compare well with the values obtained from the experimental activity coefficient plot, which are $A = 1.18$ and $B = 0.535$.

Using the experimental A and B values, theoretical activity coefficients

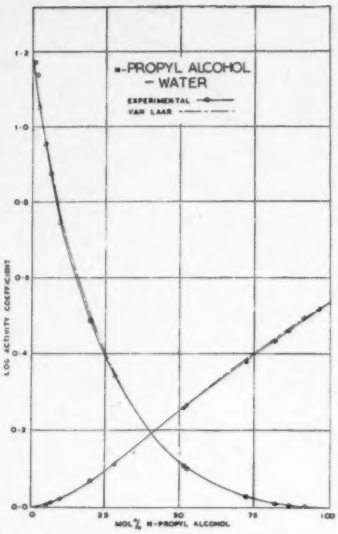


Fig. 4. Experimental and theoretical plots for the system *n*-propyl alcohol-water.

have been calculated using in this case the van Laar equations, which have been shown to be more suitable than the Margules equations for systems where there is an appreciable difference between the molar volumes of the components. In this case the ratio of the molar volumes is 4.16.

The theoretical activity coefficients are given in Table 4 and are plotted together with the experimental data from Table 3 in Fig. 4, which shows close agreement between experimental and predicted results.

Fig. 5 is the Li and Coull correlation for this system and shows that the experimental points fall closely on to straight lines. The ratio of the mean values of $(T \log \gamma)^{-0.5}$ at composition ratios 0 and 1 is 2.2 in this case, which is in reasonable agreement with the value of 2 which should be obtained.

It is concluded that the results for the *n*-propyl alcohol-water system are reasonably accurate.

Conclusions

The 40-cc. equilibrium still has been used to obtain vapour-liquid equilibrium data for two binary systems, ethyl alcohol-benzene and *n*-propyl alcohol-water. A comparison of experimental activity coefficient-composition plots with those calculated from theoretical equations has been made and a number of other tests have been applied to judge the accuracy of the results.

For the two systems which have been investigated there has been shown to be reasonable agreement between the experimental results and theoretically predicted data. Considering the small size and comparative simplicity of the apparatus, the correlation is surprisingly good and it may be concluded that it is possible to obtain satisfactory equilibrium data using a small still of the type described in this paper.

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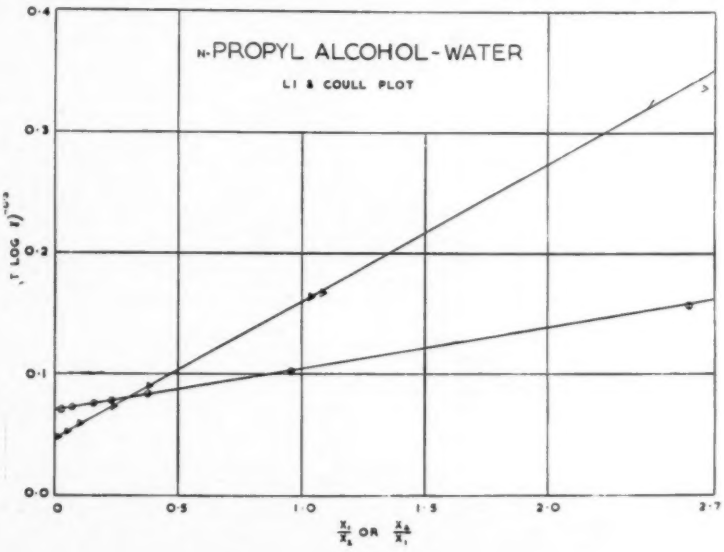

Fig. 5.

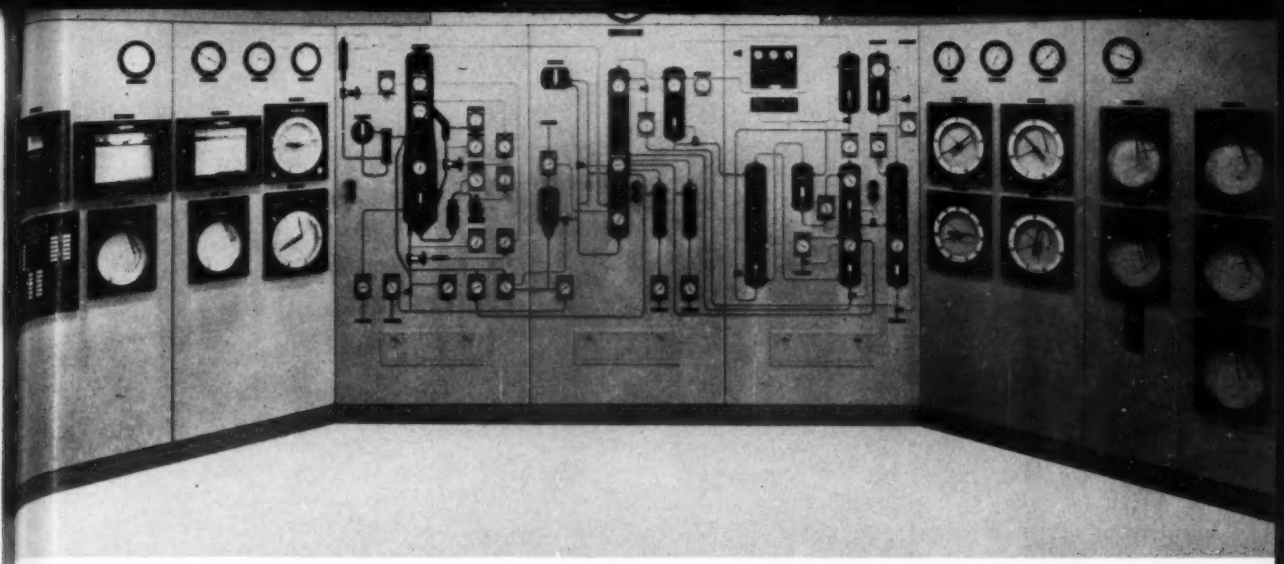

Fig. 1. A typical graphic panel. This particular panel is used to control the fluid catalytic cracking, gas concentration and L.P.G. units in an Illinois (U.S.) refinery. *[Courtesy: Sunvic Controls Ltd.*

Some Current Trends in AUTOMATIC PROCESS CONTROL

By F. B. Hinderwell, B.SC., A.M.I.E.E.

In this survey of present-day practice in the automatic control of process plants, the author compares basic types of control instruments and then goes on to discuss centralised control. Ways of meeting the need for higher sensitivity and faster response are briefly dealt with and there is an interesting discussion on the use of the force-balance principle in pneumatic and electrical instruments. Finally, controller settings and also scanning and logging systems are discussed.

Types of control system

BEFORE considering the various types of control systems in general use it is instructive to examine the reasons for their introduction. It is, of course, true that many modern plants, especially those of the continuous-flow type, are so complex that it would be impracticable to control them manually, but in general the reasons for the use of automatic control are economic.

Probably the most spectacular saving achieved is that of reduced running costs owing to the smaller number of operators required. Substantial improvements can also be made in the quality of the products, and the proportion of output which is unusable may frequently be reduced. Less obvious savings sometimes result from increased thermal efficiency, which cuts down the fuel bill, and closer control of process conditions can reduce maintenance costs by protecting the plant from extremes of temperature or acidity.

In order to obtain the necessary sensitivity to small changes in process variables, control instruments must almost invariably incorporate some form of power amplification. Although purely mechanical amplifiers are possible, most conventional systems make use of hydraulic, pneumatic or electric amplification, or occasionally a combination of two of these media. Handled pneumatically or electrically, data can also be transmitted over appreciable distances, which becomes necessary when a plant is to be controlled from a central point.

Hydraulic operation has been little used, as it is difficult to maintain a completely leak-tight transmission system and, moreover, each instrument must be provided with both a supply and return line. With a pneumatic system, small leaks can usually be tolerated and any surplus air can be exhausted to atmosphere, making the use of return lines unnecessary. It is interesting to note, however, that, owing to the current need for increased speed of valve operation, the use of hydraulic power is now receiving more attention, as it avoids the time lag in changing the diaphragm valve air pressure when this has to be controlled from a source of limited capacity.

The need for amplification and ease of data transmission can also be met by electrical systems and, where transmission over an appreciable distance is required, this method may be preferred, both for enhanced speed of response and reduced installation cost of wiring compared with pneumatic piping. Electrical control instruments, however, have in the past tended to be more complex and difficult to maintain than their pneumatic counterparts, and the need for expensive flameproof enclosures in hazardous areas has also discouraged their use to any great extent. An exception is in the measurement of temperature in cases where it is necessary to use a thermocouple as the primary element. Since there is

at present no simple way of converting a thermocouple output to a proportional air pressure, electrical measuring instruments are normally used, but these are frequently fitted with pneumatic controllers to generate the necessary control action and actuate conventional air diaphragm control valves.

Modern pneumatic techniques using volume boosters to provide fast response over long transmission distances, and plastic transmission piping to reduce installation costs, in fact leave little to be desired, but nevertheless the use of electrical components is increasing owing to their high operating speed and the ease of linking them to continuous product analysers, computors and automatic logging systems, which are beginning to appear in the process control field.

Miniature panel instruments

A significant change in the general construction of control instruments has taken place in recent years owing to the increased use of centralised control. Earlier instruments were usually self-contained in a weatherproof case for mounting on the plant, and included an indicator or recorder showing the value of the controlled variable, together with means for setting the desired value. Later the measured variable data were transmitted to a central control room housing the same types of control instruments, and on bigger plants an inconveniently large panel became necessary owing to the number and size of the instruments used.

Miniature instruments were therefore developed and could be conveniently grouped together so that an operator could observe the working of the process more easily. It also became possible to show on the panel a simplified diagram of the flow lines and vessels of the plant, the instruments being mounted in their appropriate positions on the diagram. It has been argued that these ' graphic ' panels are more of a show piece for visitors than a real aid to plant operation, but they are nevertheless finding increasing use, especially in the oil industry. A typical example is shown in Fig. 1.

Sensitivity and speed of operation

With the throughput of continuous-flow-type processes steadily increasing, it becomes more and more costly to provide between each stage a buffer capacity large enough to smooth out transient process variations. It therefore becomes necessary to have a control system of sufficient speed and sensitivity to prevent even small transient disturbances, and possible means of speeding up valve operation have already been mentioned.

The use of an electric control system with a very high operating speed has frequently been suggested as the obvious means of reducing time lags, but unless the control valve can be moved at a comparative speed no overall improvement will result. Valves can be operated rapidly by electric motors, but since most valves spend a great part of their life substantially stationary it is very uneconomical to provide the high-powered electric drive needed for occasional rapid movement over short distances. At present, the usual compromise is to retain the conventional air diaphragm motor on the valve, but to provide it with a pneumatic valve positioner, which provides the necessary power amplification to achieve rapid valve travel and high sensitivity, even in the presence of considerable friction and variable unbalance forces in the valve.

The force-balance principle

As previously mentioned, high sensitivity in control instruments is achieved by amplifying any error between the measured variable and its desired value, but in earlier instrument designs this sensitivity was limited by the presence of friction in the mechanical linkages used. The need for these linkages arose since the desired and measured values were fed into the controller in positional form, pneumatic or electric means being used to detect a ' position balance ' between the two variables. Since the available forces from primary measuring elements such as the Bourdon tube are comparatively small, very light levers and pivots had to be used, and the maintenance under plant conditions of a friction-free system was not easy.

To eliminate the use of these linkages, instruments were developed which worked on a balance of forces rather than the alternative position-balance system. This principle is illustrated in Fig. 2, which shows a simple form of pneumatic pressure transmitter. The input is applied on one side of a flexible diaphragm to which is secured a baffle plate operating close to a nozzle. Air is supplied through a restriction to the other side of the diaphragm and exhausts to atmosphere through the nozzle. Any difference between the input pressure and the pressure below the diaphragm varies the clearance between the nozzle and the baffle, which controls the flow of air through the fixed restriction and hence the pressure drop across it. The pressure below the diaphragm is therefore varied until a force balance is achieved when the two pressures are equal, and an output air pressure is produced equal to the input pressure.

By using multiple diaphragms this system can be used as a sensitive detector of any difference between two input pressures and, if these two inputs are made proportional to the measured value of a process variable and its desired value, we have the essence of a process controller working entirely on a balance of forces. The movement of the diaphragm required to vary the output pressure from its minimum to maximum values is only about 0.002 in. and the system is completely free from friction.

The same principle can be applied to electrical instruments, as shown in Fig. 3. Here the input is a mechanical force applied to the armature of an electro-magnetic coil. Any movement of the armature moves a vane relative to the oscillator coil of an electronic oscillator and amplifier unit and varies the degree of tuning of the oscillator, which in turn is arranged to vary the output of the amplifier. This output is fed back to the electro-magnetic coil and the resulting magnetic force opposes the input force. A force balance is achieved when the vane is so positioned relative to the oscillator coil that the feedback is just sufficient to provide the necessary balancing current.

As the total movement of the vane necessary to change the output from minimum to maximum is only a few thousandths of an inch, the system depends essentially on a force balance rather than a position balance, and the output current from the amplifier is directly proportional to the input force. It will be clear that, by adding a second electro-magnetic coil and spring loading the armature, an electrical input can be used in place of the mechanical force.

The force-balance principle, applied either pneumatically or electrically, has resulted in a considerable increase of control instrument sensitivity, and

To Authors

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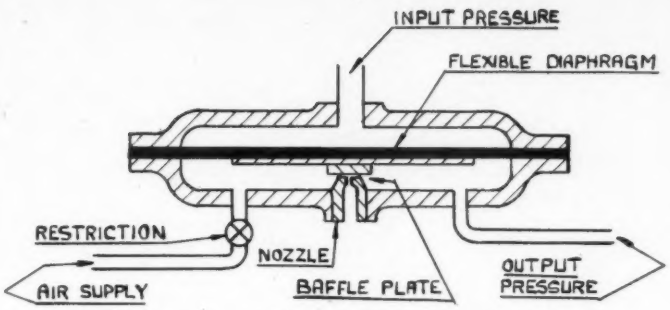


Fig. 2. Force-balance pneumatic transmitter.

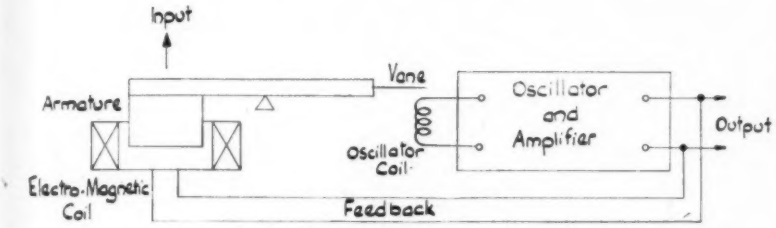


Fig. 3. Electrical force-balance unit.

force-balance instruments can also be made extremely robust and reliable owing to the absence of moving parts.

Controller settings

Even the most sensitive and potentially accurate controller can give only inferior control if it is not correctly set up and matched to the plant. The setting of a simple proportional-type controller presents no difficulty, as it is only necessary to adjust the proportional band until the best compromise is achieved between excessive overshooting and oscillation following a process change, and the other extreme of good stability but with excessive offset error persisting after a process change.

When a two-term controller is used, optimum settings must be found for the proportional band and integral action time and, although rule-of-thumb methods can be reasonably successful, a more logical approach is desirable. If it is necessary to add derivative action the problem is further complicated, and determination of suitable settings by trial and error can be a lengthy and expensive business.

The application of frequency-response analysis to this problem has enabled a logical method to be developed for obtaining the optimum controller settings for a given process. Frequency-response characteristics of the controller can easily be measured and, if the corresponding characteristic for the process can be obtained, it is a relatively easy matter to calculate the optimum settings. Practical difficulties arise, however, in determining the process characteristics, owing to the high attenuation of the average process and the frequent impracticability of applying to it sufficiently large deviation signals to produce a measurable output. The difficulty is aggravated by the presence of small random output signals arising from the process and obscuring the signal to be measured. Despite these obstacles to a completely logical approach, the increased understanding of control system performance resulting from frequency-response studies has provided an invaluable guide and enables satisfactory controller settings to be obtained with the minimum amount of experiment.

End product control

Conventional control systems are usually arranged to keep such variables as temperature, pressure, flow, etc., throughout the plant at fixed values which are known to give a satisfactory end product. In complex plants it is difficult to determine the optimum values of all the process variables under all conditions, especially as there is usually considerable interaction between the variables. It is logical to attempt some form of overriding control actuated directly from the quality of the end product, and some progress in this direction has been made by the use of continuous analysers. An example of this technique which has found practical application is the use of an infra-red spectrophotometer to control the concentration of particular hydrocarbons in a fractionating tower.

The relationship between end-product quality and the values of conventional process variables is usually complex, and the use of an electric computor for continuously determining the optimum controller settings has been suggested. This technique is still in its infancy, but will no doubt be increasingly applied in the future, and the convenience of electric control systems for such applications will be readily appreciated.

Scanning and logging systems

Apart from the important variables used for automatic control purposes, there are often numerous subsidiary variables whose values are occasionally required for supervisory purposes, or which must be recorded for subsequent analysis, *e.g.* for cost accounting or investigation of plant defects and improvements. It may also be necessary to operate an alarm when any one of a large number of variables exceeds a predetermined value. Various types of automatic and semi-automatic scanning systems have been developed to meet this requirement. One system uses uni-selectors of the telephone type, enabling any variable to be dialled and its value displayed in a few seconds; another employs fully automatic scanning and a cathode ray tube display.

For recording purposes there is an increasing tendency to use digital techniques rather than employing numerous chart recorders. The data to be recorded are converted from analogue to digital form and printed out by an automatic typewriter, or recorded on punched tape for subsequent analysis.

Technical charts. A series of technical charts, which should be useful to anybody whose business entails design work and the production of chemicals, is being issued by Horace Priest Chemical Engineering Co. Ltd. The charts will cover a very wide range of subjects, including distillation, heat exchange, absorption, liquid and gas extraction, evaporators, general properties of chemicals and mechanical design requirements. Four which have come to hand so far are concerned with log. mean temperature difference, temperature conversion (two charts) and Reynolds' number. Each chart is printed foolscap size on heavy paper so that it can be filed. Periodically, an index will be issued to form a complete reference book.

New Engineering Developments

LATEST PLANT AND EQUIPMENT SHOWN IN LONDON

At the Engineering, Marine and Welding Exhibition, held in London last month, the interests of the engineer in the chemical and allied industries were fairly well served by a number of recent developments in the way of chemical plant and equipment, materials of construction, etc., as well as more general items such as boiler plant, compressors, electrical apparatus, etc. Some of these are touched upon in the following brief review.

VARIOUS types of equipment for **dust and fume control,** including a unit for controlling dangerous invisible dust from stand grinders, were exhibited by Air Control Installations Ltd. Two types of *Rotoclone* equipment included a dynamic precipitator for dry collection of almost all types of granular industrial process dust, and a hydrostatic precipitator in which the cleaning action is obtained with an inverted-S-shaped water curtain.

Audley Engineering Co. Ltd. made a feature of **remote control of valves** and there were a number of interesting demonstrations showing how this could be achieved by various means. Particularly interesting to operate was a typical panel for the electrical remote control of a number of cylinder-operated valves; as the controls were operated, lights flashed on or winked to warn the operator what was happening to the valve.

Among the **strainers** shown by Auto-Klean Strainers Ltd. was a large automatic unit for Davy & United Engineering Co. Ltd. This unit was for installation in the steel rolling mill plant at Empresa Nacional Siderurgia S.A. of Madrid, and was designed to strain 200 gal./min. of lubricating oil at viscosity 300 sec. Redwood No. 1. It had three 7 ft. 6 in. diameter elements.

Babcock & Wilcox Ltd. exhibits included a comparatively small example (3,000 lb./hr.) of the *Steambloc* **boiler,** which provides **packaged - power steam plant** in a range of sizes from 1,500 to 18,000 lb./hr. The boiler is a completely self-contained unit which incorporates all auxiliary plant, and it is oil fired with automatic control. A point made by the makers is that the *Steambloc* requires little more than half the space needed for conventional boiler plant and a special boiler house or tall chimney stack is not necessary since it is a forced-draught unit needing only a rudimentary vent for exhaust gases. The boiler is handled by the Babcock subsidiary company, Spencer-Bonecourt-Clarkson Ltd.

The Babcock stand also featured pneumatic operation of sootblowers, a shot-cleaning system for horizontal-tube surfaces and a display of various types of poor-grade fuel which are being successfully burned in spreader-stoker installations.

Bakelite Ltd. were exhibiting in the Foundry Trades Exhibition, and showed examples of blow cores in pre-coated sand and dry mix; a variety of **shell moulds** in dry mix and pre-coated sand; a core produced by using a phenolic liquid core binder; and an example of stack moulding using shell moulds.

Another stand, featuring process heating equipment, included a vertical-loading **electric oven** used for such processes as baking, curing, drying, preheating, shrinking, stoving, etc. It has been designed to eliminate the unnecessary handling of components, as, by utilising a suitable overhead light gantry or runway, the parts to be treated can remain in the work baskets for several stages of the process being carried out. They may also be used for single larger components. Although primarily designed for work carried in baskets, this oven can also be used for single units. It has enclosed heaters and forced air circulation, whilst an accurate temperature control and safety thermostat are installed. An insulated cover with cam-action lever which raises and swings to one side is another special feature of this equipment. The control gear is housed in a steel-clad control panel mounted to one side of the oven. Barlow-Whitney Ltd. were the exhibitors.

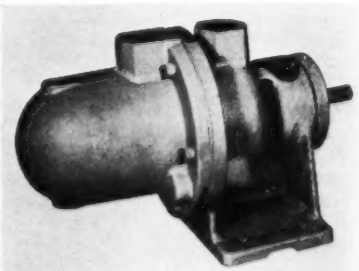
Among the industrial exhibits on the stand of the British Thomson-Houston Co. Ltd. was a 230-kva. engine-driven **alternator set.** The set consists of a Davey, Paxman 8-r.p.h. diesel engine with a B.T.H. 184-kw., 415-v., 50-cycle alternator, flange mounted and overhung from the prime mover.

Another engine-driven alternator set was a 6.25-kw. *Stavolt* unit, developed primarily to meet the requirements of a simple low-cost a.c. generating plant for providing electric light and power in isolated places where no electricity supply is available.

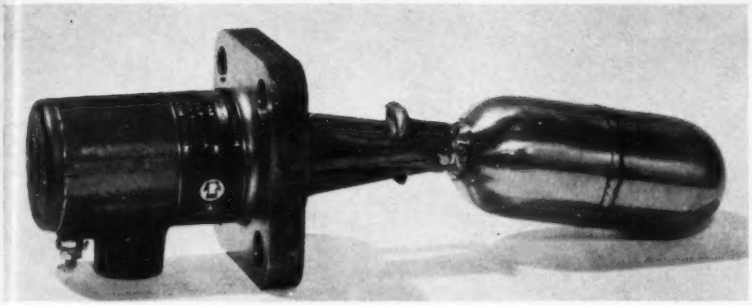
Fibreglass Ltd. showed various applications of their insulation materials and **reinforced plastics** in the marine field, these materials also having numerous applications as structural materials in industry. Ducting, tubes and vessels may be produced by wrapping plaster, wood or metal forms with wet resin impregnated with cloth, tape or roving and, after curing, removing the form. Lining of chemical stoneware or other relatively low-strength or damaged plant can also be carried out.

The Gas Council's stand demonstrated various uses of **gas in industry** and included a new automatic coke-fired boiler. A flame control unit for the protection of gas-fired ovens, furnaces, boilers, kilns and similar installations utilises the effect that flame is a partial conductor of electricity. A flame detector, electrically connected to the control unit, projects into the pilot flame and a circuit is completed *via* the flame, to earth. This circuit retains electrically operated gas valves in the open position. Immediately the flame fails the circuit is broken and the valves close, shutting down the gas supply. The *Flamestat*, as it is called (supplied by Radiovisor Parent Ltd.), may be connected to any type of electro-magnetic or motorised control valve.

Examples of their **explosion suppression and protection** equipment, briefly referred to in an article in our September issue, were shown by the Graviner Manufacturing Co. Ltd.



Mono pump for cooling-water duties.



A stainless-steel level switch (horizontal mounting) shown by Ronald Trist.

One example of a system combining suppression with relief is that which can be applied to a spray drier system including a cyclone and bag filter. The most likely source of ignition is the gate valve at the bottom of the two powder-collecting ducts. These ducts are protected by high-rate discharge bottles, so that in the event of an ignition at the gate valve there would be little possibility of flame passing to the large spray drier chamber. The spray drier chamber itself is protected by a series of hinged relief panels opened by detonator-operated actuators. The cyclone has its own detector and is protected by an armour-plate glass bursting disc. To prevent flame from the cyclone penetrating to the spray drier chamber, the communicating duct is inerted by a high-rate discharge bottle.

An interesting demonstration of how **silicone rubber** retains its elasticity at extremes of temperature was provided by Imperial Chemical Industries Ltd. Three lengths of silicone rubber tubing, E.360, were subjected to a steadily recurring pulling force, but two were kept at a constant temperature of -80°C. and +200°C., respectively, while the third remained at normal temperature. There was no visible difference in the elasticity exhibited by the three lengths of tubing. Gaskets and seals subject to high- or low-temperature operation are among the applications of silicone rubbers.

A new **industrial *x*-ray equipment** is stated to be the first to be designed and manufactured in Britain employing gas insulation for both *x*-ray tube and transformer. The absence of high-voltage cables, rectifying valves and other ancillaries gives this equipment advantages where welded joints up to 1½-in. thick have to be examined on open constructional sites. The high-voltage transformer and the associated transformer for heating the filament of the *x*-ray tube are both contained in a cylindrical steel tank 18 in. in diameter. The *x*-ray tube is directly connected to the high-voltage transformer in the same tank, but the target or *x*-ray source is at the end of a small-diameter pipe projecting 18 in. from the main tank. The target extension tube can thus be inserted into hollow castings or the complete transformer tube head can be placed inside pipes and pressure vessels larger than 18 in. in diameter. The use of sulphur hexafluoride for the insulation of both transformer and *x*-ray tube keeps the weight to a minimum and at the same time, it is claimed, improves reliability owing to the absence of any of the problems associated with insulating oils at high temperatures. A robust metal box conveniently arranged for transport houses the controls for kilo-voltage, milliamperage with the associated instruments and exposure timer with a range of 0 to 55 min. in intervals of 1 sec. together with the usual switches and indicating lamps. A compact air-cooled water circulator provides a constant flow of water for cooling the *x*-ray tube target which is at earth potential, thus making the equipment independent of the qualities and pressure of mains water supplies. This equipment was shown by Newton-Victor Ltd., a subsidiary company of Metropolitan-Vickers Electrical Co. Ltd.

The stand of the Mond Nickel Co. Ltd. featured a new device that assists in the choice of **metals** for a given combination of properties. Pointers are set to the properties required and the appropriate materials are shown by light indicators. Easy requirements show up a great many metals, while more exacting needs reveal only one or two.

Demonstrations of **pumps** handling pulps and oil-sludge residue were provided by Mono Pumps Ltd. One of the new items displayed on this stand was a vee-belt-driven unit which is intended for use as a cooling-water circulation pump. The pump has a nominal capacity of 165 gal./hr. Where convenient power take-off is available its compact dimensions (11 in. × 5¾ in. × 6⅜ in.) make it suitable for mounting on main or auxiliary machinery.

Carbon-lined stainless-steel tubing was exhibited by the Morgan Crucible Co. as well as *Carbinert* impervious **carbon and graphite,** applications of which include tube bundle heat exchangers, cascade coolers, plate heaters, bayonet heaters, etc. A full-sized *Carbinert* cascade cooler was shown. A selection of *Carblox* carbon blast-furnace refractories and chemical tank linings manufactured by Carblox Ltd. was also included.

A variety of **centrifuges** and other equipment was shown by Sharples Centrifuges Ltd., including a new pilot-plant *Super-D-Canter* known as the model P-4. This machine has an average feed capacity of 1 gal./min. and a maximum feed rate of up to 2½ gal./min. and, in consequence, test work can now be carried out on as little as 5 gal. of slurry. Apart from the application of the P-4 machine to testing the separation characteristics of slurries for scaling up to full-sized plant, it can also be used for small-scale production work, for pilot-plant operation and as a general laboratory tool. This stand also featured the Sharples *Super Centator*, embodying a new approach to countercurrent extraction and consisting of a balanced rotating bowl which is driven by a 1½-h.p. electric motor at speeds of 15,800, 19,700 or 23,650 r.p.m. as desired. The bowl rotates within a heavy cast frame equipped with a door so that it will contain solvent vapours. The mixing and separating assembly, which is the heart of the unit, is available in from one to five stages. Each stage is composed of a mixing zone and a separating zone. The two actions of mixing and powerful centrifugal separation take place almost simultaneously. Since proper placement of ring dams impels the heavy liquid to travel upward and the light liquid to travel downward, extraction takes place in a countercurrent manner.

A range of **automatic control equipment** shown by Teddington Industrial Equipment Ltd. included a general-purpose pressure switch, type GM, fitted with a snap-action silver contact switch carrying 10 amp. a.c., or 5 amp. d.c., 250 v. Other equipment was shown for temperature, pressure and humidity regulation in heating, air conditioning, refrigeration and all types of process plant.

The chemical engineering department of John Thompson (Dudley)

Ltd. showed exhibits representative of their work in the field of **pickling and acid recovery plant.** A working model demonstrated a rotary process plant supplied for pickling coiled strip. A full-scale pickling cage used in this plant was available for inspection, together with a measuring vessel and an example of a lead-covered copper coil for steam heating the acid baths. A model of a complete acid recovery plant was also on show.

A working demonstration of the *Mobrey* magnetic **level switch** appeared on the stand of Ronald Trist & Co. Ltd. This is a float switch suitable for fitting into tanks and similar vessels for indicating or controlling the level of a liquid. The float assembly carries with it a permanent magnet which is opposed by a similar magnet in the switch assembly. The adjacent poles of the two magnets are arranged so that they repel each other. It is this principle which is employed to change over the switch contacts with a snap action. A wide range of switches are available, in various materials, all being glandless in design.

Gear wheels, bearings, bushes and other components of **Tufnol** for use in chemical plant were shown by Tufnol Ltd. and the corrosion resistance of these components, even when immersed in corrosive solutions, was stressed. As an example of the successful use of this material to combat corrosion by electrolytic action, an oil pipeline coupling with a flange insulating disc and bolt jackets and washers produced from *Tufnol* were shown. Other exhibits included a lens tray that will not scratch lenses and is stated to be unaffected by the corrosive solutions in which they have been immersed, and a scoop that resists corrosion from chemicals and, it is claimed, will not spark to ignite inflammable materials or explosives.

On the stand of Henry Wiggin & Co. Ltd. **high-nickel alloys** were illustrated in various corrosion- and heat-resistant applications. Colour photographs depicted the use of nickel, *Monel*, *Inconel* and *Corronel B* in various types of plant for the manufacture of processed foodstuffs, essential oils, caustic soda, fatty acids and fertilisers, and also in pickling and other chemical processes. Further colour pictures showed some of the many duties to which the Nimonic series of heat-resisting alloys are being successfully applied in industry, *e.g.* for the high-temperature parts of vitreous enamelling furnaces, pottery firing furnaces and industrial gas turbines.

OZONE

(*Concluded from page* 357)

dry air absolutely essential for the production of ozone at high concentrations, but the capital cost of the drier is more than offset by the greater ozone yield and the consequent reduction in size of the ozoniser. The air is usually dried to a dewpoint considerably below 0°C. by means of silica gel or activated alumina. The importance of adequate air velocity through the discharge space is evident from the above equation, since removal of ozone as soon as it is formed will displace the equilibrium towards the right. However, a very high air velocity has a quenching effect on the discharge, because some of the ions are blown through the discharge space before they have time to reach the opposite electrode. The yield/air velocity curve rises to a flat peak and then slowly decreases.

High temperatures also reduce the ozone yield. The air stream passing through the ozoniser generally provides sufficient cooling when only low concentrations of ozone are required, but industrial ozonisers are usually water cooled.

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Europe's Cement Industry Looks Ahead

CEMENT production in Europe has developed and is continuing to develop very rapidly. Over the last three years the expansion of this long-established industry has been comparable to that of more recent and highly progressive departures (petroleum chemistry, aluminium, synthetic fibres, etc.) and has exceeded the average for industry as a whole. In the O.E.E.C. countries, output nevertheless increased more slowly from 1951 to 1954 (about 25%) than from 1948 to 1951 (about 50%). In 1953, the European cement industry, which is quite capable of meeting domestic requirements, produced over 59 million tons, valued at from $650 million to $700 million. In 1954, output rose to over 62 million tons.

Whereas there are still some large-scale projects for increasing production capacity, it is clear that the longer-term prospects for demand are not as certain as might be deduced from the trend recorded over the last few years. If the development of consumption is to be proportionate to the expected increase in production, it is important that building programmes should develop, that the tendency to substitute cement for other materials should become firmly rooted and that the use of cement, for instance for the building and development of road networks, should be developed on a large scale, as has been done in the United States.

This is the main conclusion of the overall survey* of the situation in the European cement industry carried out by the O.E.E.C. Cement Working Party. The survey contains interesting data on the programme for expanding the industry in O.E.E.C. countries. The Italian projects for expanding the industry's capacity are the most far-reaching, in that seven new works will be built, equipped with seven rotating kilns representing an annual production capacity of 735,000 tons. The United Kingdom plans to build a works in 1956 with one rotating kiln and a capacity of 175,000 tons. In Denmark, it is envisaged to install in 1957 a works with one rotating kiln of 125,000 tons capacity. Full information with regard to German projects is not available, apart from one works due to be completed in 1955 equipped with two kilns. In addition, Italy has plans for installing in existing works during the next three years 11 rotating and three vertical kilns, *i.e.* a capacity of 1,340,000 tons. During the same period, Belgium plans to install five rotating kilns to replace existing units, Austria four rotating kilns and two vertical, Sweden three rotating kilns, Switzerland two rotating kilns and two vertical, and France two rotating kilns and one vertical. Denmark will put one rotating kiln into operation in 1955. Turkey has a considerable development programme, as a result of which its production capacity might be doubled by 1957. From all these forecasts, it emerges that production capacity in the various countries will increase substantially in the next three years, especially in Italy, France, the United Kingdom and Turkey.

**The Cement Industry in Europe.* O.E.E.C., Paris. Pp. 70. 7s.

New Books

Process Control System Design

AN important feature of process control when compared to the related fields of servo-mechanisms and electrical communications is the almost completely empirical approach to the application of automatic control in the process industries. Whilst control equipment of satisfactory performance has been developed, the application of such equipment is still largely dependent on experience and empirical, if not trial-and-error, methods. The full potentialities of the automatic control of process operations are rarely obtained or even appreciated and this is particularly the case in connection with the design of plant which is too often carried out without consideration of the control requirements. The quantitative study of the process characteristics as such and their effect on the control system as a whole has been much neglected in the past and such information as is available is mainly only qualitative. The theoretical development, parallel to those in the related fields, has been generally impeded by the complex mathematics required for the treatment of even relatively simple systems.

The present book* provides an introduction to the study of process control systems and of the factors influencing the design of such systems, based essentially on the experimental method of frequency response analysis of the process, the application of which has been so successfully developed by the author, who is the head of the Central Instrument Section of Imperial Chemical Industries Ltd., and his colleagues. Whilst much of the subject-matter is not original, it is here collated with much of the unpublished work of the author and his colleagues with a consistent terminology based on the draft revisions of the British Standard Glossary.

The book is not primarily intended for the instrument engineer or technician, although much of interest and value will be found, but rather for those concerned with the design and operation of process plant to whom process control is an important factor in increasing efficiency.

Process characteristics and their effects on controllability are first examined qualitatively with the emphasis placed on the dynamic characteristics and using only the simplest mathematics. The experimental method of frequency response analysis is described in detail and after considering the characteristics of the theoretical controller with proportional, integral and derivative actions, the operation of a continuous control system is reviewed with regard to the prediction of controller adjustments, the quality of control, and the 'controllability' of the plant. Several chapters are devoted to the design of practical controlling instruments and their frequency response characteristics investigated. The effect of measuring and transmission lags, transfer stages with lumped and distributed parameters and including the response of heat exchangers, and the effect of disturbances on the control system are considered. In the final chapters the treatment of complex control systems, such as cascade, ratio and averaging controls, is discussed and a procedure for the design of process control systems, based on the principles elaborated in the preceding discussions, is described.

The mathematics is reduced throughout to the barest essentials, data being presented in graphical form to facilitate the use and interpretation of formulae and equations.

The author is to be congratulated on the logical development of his subject and the clarity of his exposition. This book is a valuable contribution to the literature of process control and should stimulate still greater interest in the investigation of plant and process characteristics on which the practical and quantitative approach to process control depends. The publishers have produced an attractive, well-bound and excellently illustrated volume at a remarkably reasonable price.

A. POLLARD

**An Introduction to Process Control System Design*, by A. J. Young. Longmans, 1955, pp. 390 inc. index, 42s.

Rubber for Engineers

The unique properties of rubber make it a valuable material for numerous applications in engineering, but while the engineer is fully conversant with the properties and uses of the various metals which he has to employ, he is frequently not so well versed in the characteristics and applications of rubber. The purpose of this book* is to provide the necessary information to enable the engineer to make effective use of rubber.

The author was formerly in charge of the rubber laboratories of Imperial Chemical Industries Ltd. and, during World War 2, much research and development work for the Services was conducted in these laboratories. In the course of this work the author had many contacts with engineers and this has enabled him to view the subject from the point of view of the engineer who wants to incorporate rubber in his designs.

Over half the book is devoted to specific engineering uses of rubber. In the remainder, the sources, properties, manufacture and testing of rubber are covered. The chapter on manufacture has been included to enable the engineer to take an intelligent interest in the material. The book is copiously illustrated with photographs and diagrams.

**What Every Engineer Should Know About Rubber*, by W. J. S. Naunton. The British Rubber Development Board, 1954. Pp. 126, illustrated. 3s. 6d.

Planning, Erection and Running of Chemical Works

Textbooks of chemical engineering usually put the emphasis on unit operations and process control, and the more general problems connected with the planning and the running of chemical works are often neglected. The book* under review promises to fill this gap, but hardly succeeds in doing so.

The author, late lecturer in the German Technical University of Prague and the Technical University of Vienna and now industrial consultant in Stockholm, has written two textbooks on the chemistry of cosmetics, and it is apparently this branch of chemistry in which he feels most at home. The present volume is the third enlarged edition of a book originally called 'Die Chemisch-pharmaceutische Fabrik,' which was a better title, as the new one is rather misleading.

There are short chapters on works and research laboratories, prevention of accidents, first aid, works accountancy, buying, selling, publicity, bookkeeping, patents and trade marks, and longer ones on power and heating problems, equipment and unit operations, but the main part of the book deals exclusively with the manufacture of pharmaceutical chemicals and cosmetics, and the names used for many chemicals are those which a pharmacist, rather than a chemist, would use.

This part contains too many details—such as instructions for the manufacture of 'magnesium sulfuricum purum crystallisatum' and many other salts, soaps, ointments, sticking plasters and face powders—which are not essential to the main purpose of the book.

None the less the young pharmacist who has just finished his training and the chemist who has worked only in laboratories will find much in this book to help them on the way to a better understanding of the problems connected with the manufacture of drugs and cosmetics.

**Die Chemische Fabrik—Aufbau, Betrieb, Führung* (The erection, operation and management of chemical works), by Dr. H. Truttwin. Ferdinand Enke Verlag, Stuttgart. Pp. 220 + 5 charts, illustrated. DM. 32.

Higher Creep Strength for Molybdenum Compositions

It has been found that stable oxides of certain metals dispersed in molybdenum produce compositions with greater creep strength than those of conventional molybdenum alloys. Using powder-metallurgy methods, metallurgists have created molybdenum oxide compositions with creep lives more than twice as long as those of ordinary molybdenum alloys at temperatures of 1,800 to 2,000°F.

This improvement in creep strength—or the ability to withstand high stresses at elevated temperatures without deforming—was accomplished without altering room-temperature properties of molybdenum. Most effective strengtheners among the oxides studied were the hard, stable, insoluble oxides of zirconium, titanium and chromium.

Experiments on the conventional alloys of molybdenum, made by powder-metallurgy methods, showed that those made with silicon, chromium, aluminium and tungsten have the best creep lives at 1,800°F.

The research on the creep properties of molybdenum compositions was carried out at the Battelle Institute, Columbus, Ohio. It was reported in a paper prepared by W. L. Bruckart and Dr. R. I. Jaffee and presented at a meeting of the American Society for Testing Materials. Outstanding among oxide additives were zirconium oxide and titanium oxide, while silicon was the best alloying metal. At 1,800°F., some of the oxide additions increased the 100-hr. creep rupture strength of molybdenum almost fourfold. Present research at Battelle suggests that further increases in molybdenum creep life may well come from compositions including both metallic and oxide additions.

When molybdenum alloys are exposed to elevated temperatures, they need protection against oxidation. For that reason, the research also included experiments on the effects of cladding materials on creep properties. It was found that nickel cladding has no effect on creep life. A protective coat of nickel limits total elongation of molybdenum parts to between 7 and 9%, somewhat lower than for unclad molybdenum. This amount of ductility, however, is still sufficient for most high-temperature applications.

RECENT PUBLICATIONS

Tower packings are the subject of a new technical booklet issued by Weinreb & Randall Ltd. Information on Raschig rings and Berl saddles is included and there are sections on materials of construction, pressure drop, variation of efficiency with packed height, theoretical plate values, improvement of liquid distribution, and packings as catalyst carriers. A bibliography is also included.

Silicate storage and distribution. A booklet from Joseph Crosfield & Son Ltd. provides a comprehensive guide to the design and construction of bulk storage and distribution systems for sodium and potassium silicate. There are 11 pages of text and tables on means of transport, storage tanks, pumps, pipelines, valves, measurement of stocks, level control, and storage and distribution schemes with, finally, some diagrams of typical installations.

Melamine resins. Melamine is manufactured by the British Oxygen Co. Ltd., and various melamine-formaldehyde resins suitable for laminating and adhesive applications are available from a number of resin manufacturers in the U.K. The purpose of Technical Bulletin No. 2 issued by British Oxygen is to describe the general procedures for making resin syrups suitable for the production of laminates and adhesives. Melamine-formaldehyde resin syrups are obtained by condensing melamine with aqueous formaldehyde solutions at an elevated temperature. The melamine dissolves with the formation of methylol derivatives. On further heating, reaction continues with the elimination of water and formaldehyde to form a series of condensation products which are increasingly hydrophobic. When the desired degree of condensation has been reached, the resin may be concentrated to any desired solids content, and diluents, stabilisers, etc., added as required.

Tubular heat exchangers are dealt with in Publication 155 from Wellington Tube Works Ltd. Various types of tubular heat exchangers are described and illustrated and then there is a section on materials of construction. Four pages are devoted to mechanical design and to its effect on cost. Standard and special designs of exchangers are featured and the characteristics of heat-exchanger tubing are tabulated.

Mercury-arc rectifiers. A 28-page booklet (R.190) from Hackbridge & Hewittic Electric Co. Ltd. features the company's range of rectifiers. It is stated that these rectifiers have advantageously supplanted local d.c. generators supplying steel rolling mills and that many are operating heavy cranes and lifting magnets, coke oven plant, d.c. plant in factories, chemical works and gas undertakings, and variable-speed drives in printing works, paper mills and textile mills. In addition, they have been installed in laboratories, including fuel research and nuclear research stations and for operating pumping apparatus in waterworks, etc. The booklet includes over 50 illustrations and diagrams.

Metal detector. Electronic equipment for automatically detecting and signalling the presence of ferrous or non-ferrous metals is described and illustrated in a pamphlet by Metal Detection Ltd.

Letter to the Editor

SIR,

I venture to send you a chemist's problem and so start a hare which should prove tasty if it reaches the jugged state.

Reflecting on the time schedule for a tunnel job, it occurred to me that the interval from shot firing to the start of mucking out was excessive, and I wonder if chemists have ever sought a gas, liquid or whatnot to counter the gases given off by the explosion. The wait for dilution by air means a lot of wasted time.

Yours faithfully,

J. N. WILSON.

8 Burn View,
Bude, Cornwall.

Plant and Equipment

PTFE flexible tube and pipe

A new flexible tube and pipe unit made from PTFE (polytetrafluorethylene) is expected to find applications in the fields of chemical and food processing as well as in the aircraft industry. It is claimed that the tube retains full flexibility over the temperature range —100 to +250°C. and that, under certain circumstances, the upper temperature limit extends to 300°C.

It is further claimed that the tube has complete resistance over this temperature range to all oils, hydraulic fluids, fuels, acids, alkalis and solvents. Light weight, stability, non-wetting properties and non-inflammability are further features pointed out by the makers.

At present, the tube is being produced in a limited range of sizes, up to 1-in. bore, but other sizes will be added in time. The tube is stated to be of sufficient wall thickness to give an extremely low permeability factor—a point of special importance when high concentrations of acids are encountered.

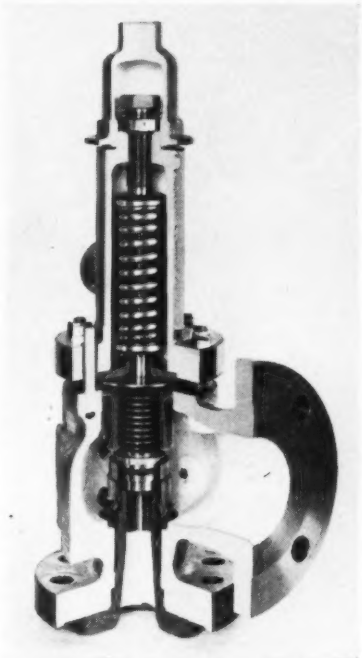
Bowden (Engineers) Ltd. are the suppliers of these units, which are made from *Fluon* PTFE supplied by Imperial Chemical Industries Ltd. Bowden state that high-working pressures up to 5,000 p.s.i. are readily obtained in their PTFE flexible pipe units by high tensile wire braid reinforcement when combined with patented lip-seal couplings.

Bellows-sealed relief valve

A new relief valve is designed primarily to operate against varying downstream or back pressures without any effect on the lifting pressure. This is achieved by sealing the body of the relief valve from the bonnet or spring case with a stainless-steel bellows. The effective area of the bellows is exactly the same as the nozzle and disc seat area, thus completely balancing any back pressures on the downstream side of the valve.

Whilst this method of balancing back pressures has been used for several years, it has not been possible to produce a suitable bellows which will both allow the relief valve to operate normally and yet withstand discharge conditions.

Under normal circumstances the turbulence caused by sonic discharge velocity sets up a high-frequency vibration in the bellows which invariably shatters very soon after the valve lifts.



A bellows-sealed relief valve.

Rather than attempt the impossible task of producing a bellows to withstand normal discharge conditions and yet still have sufficient flexibility to allow the valve to operate normally, Crosby Valve & Engineering Co. Ltd. have adopted the policy of protecting the bellows from discharge conditions. The exclusive feature of this valve is the bellows shield. The bellows is completely surrounded by this shield and the distance between the open-ended bottom of this shield and the disc is such that when the valve lifts the top of the disc meets the bottom of the shield, thus totally enclosing the bellows and, the makers state, completely protecting it from the turbulent downstream discharge conditions.

In addition it is stated that this bellows seal also serves the purpose of completely sealing off the fluid from the guide and spring and preventing any possibility of escape to atmosphere.

The nozzle, body and bonnet of this new valve is exactly the same as the company's standard range of relief valves.

Water purification

A small twin de-ionisation plant has been developed to produce water of high purity for modern power station plant and certain industrial processes. It is claimed that the degree of purity achieved is the equivalent or greater than obtained by techniques dependent on evaporation and condensation as have previously been necessary. The cost of the process, however, is about 2s. 6d. per 1,000 gal. against about 5s. 6d. in the case of evaporation techniques, according to the makers.

The process employs pressure vessels containing synthetic resins, the contained salts in the raw water being converted to acids in one vessel and the acids being removed in the second vessel. The resins in these cation and anion exchangers are regenerated by acid and alkali treatment respectively.

The ion-exchange vessels and their pipework are constructed of rubber-lined mild steel. Pumps or injectors are used for adding the reagents and the whole process can be made automatic.

The suppliers are John Thompson-Kennicott Ltd.

Mechanised sieving of columbite

Although it has long been known that the dumps of refuse material on some tin-mining sites contained large quantities of columbite, no means of separating the columbite economically could be found until recently. Even then, the difficulty of sieving powdered columbite, owing to the curious form of the particles, proved an obstacle.

A new approach to the problem of the mechanised sieving of columbite is embodied in a new unit, which is an adaption of a machine that had originally been designed for the sieving of tracer-bullet powder. In this unit, the vibrations which promote the sieving effect are of a gyratory nature —that is to say, the mesh screen is caused to move in a minute circular orbit (this motion usually has an amplitude of about $\frac{3}{16}$ in.) and at the relatively high speed of 1,500 cycles/min. This movement takes place in a strictly horizontal plane and, the makers point out, has the effect of generating in any particulate matter placed upon the screen an entirely unique type of motion.

When applied to columbite, the 'carrot-shaped' particles are imbued with a dual motion. They rotate on their longitudinal axes and at the same

Covering a wooden rod, used in the drying of yarn, with PVC tubing to protect it from acid fumes.

time turn end over end but all the while all bouncing movement is strictly eliminated, it is claimed. It is stated that the spinning motion helps the particles to pass readily through the screen apertures, while the end-over-end movement renders it impossible for any material to stick in the mesh and cause blinding.

Power is supplied by a ¾-h.p. electric motor, while the screening assembly, mounted in compressed rubber bushes, takes the form of a *Cascade* unit. In this there are three circular screens superimposed one above the other, the whole assembly being housed in a dust-tight casing measuring 22 in. in diameter and 11 in. in height. The mesh discs are 19 in. in diameter and have a combined total area of 6½ sq. ft. Russell Constructions Ltd. are the suppliers.

Motor generator set

The Kato Engineering Co., of Mankato, Minnesota, U.S.A., has recently developed a new motor generator set consisting of a 60-cycle induction motor of low slip design driving a 31.25-kva., 25-kw., 380 to 420-cycle generator. Exact frequency changes are accomplished through a simple hand crank adjustment, it is stated.

According to the makers, design features include: (1) harmonic distortion of less than 2.9%; (2) fast voltage recovery (less than .3 sec.); and (3) voltage regulation to within ½%.

It is further claimed that the unit specifically matches requirements of precise frequency and voltage control along with ample reserve capacity. It is available on all standard voltages and also many special voltages.

Electronic computor solves process problems

One of the largest electronic computors in Western Europe, nick-named *Miracle*, has recently come into use at the Amsterdam laboratory of the Royal Dutch/Shell group of oil companies. Built by Ferranti Ltd., it was installed at a cost of nearly £150,000.

The computor will be used to solve problems in all phases of fundamental and technical research. For example, in the development of a new refining or chemical process, extensive experiments are required in order to determine the effect of a great many variations on it, on the properties of its products, and hence the best process conditions. In the course of such an investigation samples of the product are taken at regular intervals and their composition has to be determined as quickly as possible. This is done with instruments which give readings from which the percentages of the various components can be worked out. As there may be 20 or more components involved there arises the task of solving 20 or more equations with the same number of unknown factors. Their solution by normal means might take days: the computor will do the job in a matter of minutes.

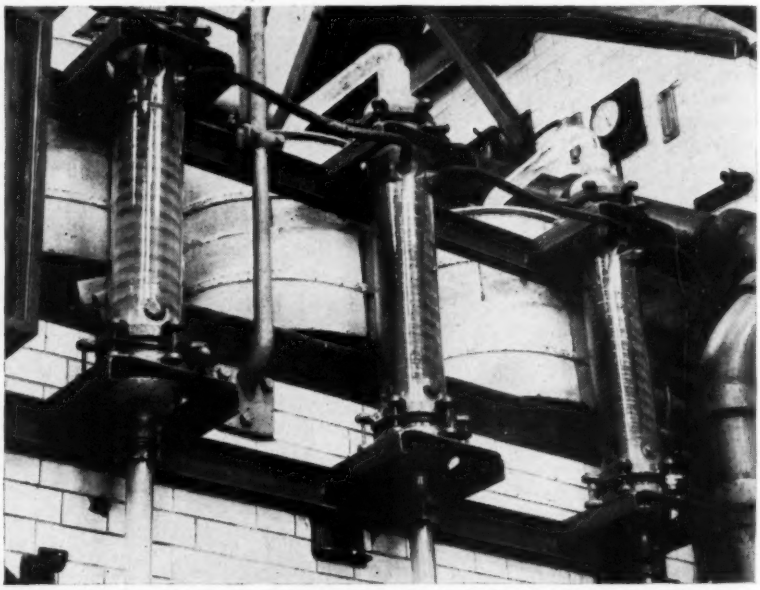
The model contains some 4,000 radio valves, 2,500 capacitors, 15,000 resistors, 6 miles of wire and 100,000 soldered joints. The nick-name, really a mnemonic, is a contraction of: *M*okum's *I*ndustrial *R*esearch *A*utomatic *C*alculator for *L*aboratory and *E*ngineering. 'Mokum' is a colloquialism for Amsterdam.

Stainless-steel flexible tube

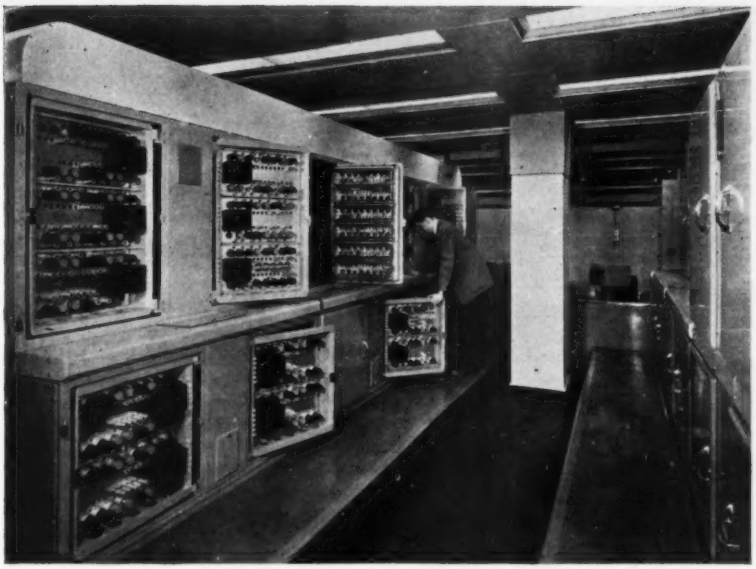
The development of seamless stainless-steel flexible tube is announced by Accles and Pollock Ltd. It is made by producing helical convolutions in thin-walled, stainless-steel tube. The plain tube for subsequent manufacture of flexible hose can be made from any of the popular types of austenitic stainless steel, and after convoluting the material is in the slightly cold-worked condition.

During the convoluting operation the wall thickness is not reduced and the finished length is slightly less than half the original plain tubing, which means that lengths of convoluted tubing are limited to approximately half the maximum lengths for cold-drawn seamless tubes.

The new development is of particular interest to the aircraft industry. To assist economic production, the company state that they are for the present limiting the sizes they propose to manufacture to a representative range decided in consultation with other interested industries. This range will be extended, however, and there is no reasonable limit to the



An illustration of the use of borosilicate glass in industrial chemical techniques is provided by these three standard 6-in. condenser units supplied to the Mond Nickel Co. Ltd. by Q.V.F. Ltd. The condensers are connected to plant evaporating chloride solutions of the platinum metals. The coolant is mains water controlled by a rotometer.



The electronic computor at Amsterdam.

process. The cost of tools for a special size is, however, comparatively high.

The first list gives seven sizes with nominal bores ranging from $\frac{3}{16}$ to $\frac{3}{4}$ in. Outside diameters range from .32 in. to 1 in. in the same range, and wall thicknesses are between .006 and .014 in.

Tools for the manufacture of these sizes are being produced to a schedule and some of them will not be available until early next year.

PVC protects wood in dyehouse

An interesting anti-corrosion precaution that is operated by Thomas Burnley & Sons Ltd., the woolcombers and worsted spinners and dyers, at their Gomersal mills, near Leeds, involves the use of PVC tubing and sheeting in their dyehouse department, where the yarn is dyed, bleached and dried. The wooden yarn rods, on which yarn is hung during the various processes, are completely covered with PVC tube fastened at each end with stainless-steel screws.

The PVC resists the attack of H_2SO_4 (sulphuric acid) and SO_2 (sulphur dioxide) fumes, which otherwise, assisted by heat (drying temperature 120 to 140°F.) would carbonise and char the wood, which in its turn would then contaminate the yarn. PVC is also iron-free, and clean yarn is ensured by the use of PVC in this way.

B.X. Plastics Ltd., who supplied the PVC, point out that the novelty of the idea would seem to make it potentially interesting to many other manufacturers faced with a similar problem.

Descaling steel after erection

It is believed that the problems encountered in weathering and other means of removing mill scale from steelwork have been substantially overcome with new descalers which are in jelly form and are applied to the steelwork after erection. The makers report that, in tests carried out over the last few years, it has been found that these jellies will adhere to and react with mill scale on *vertical* steel surfaces for sufficient time to allow the most tenaciously adherent scale layers to be entirely removed. Thus, they eliminate the need for applying shop coats; and, since the scale is retained to a great extent until after erection of the steelwork, the danger of severe rusting is very much reduced.

The jellies are supplied by Jenolite Ltd.

For further details of the plant and products described, please use the coupon on page 378

NEW PRODUCTS IN BRIEF

Three-position electronic temperature controller with particular applications for the plastics industry but stated to be equally suitable for many other industrial processes. Basically, instrument is a normal proportional temperature controller, but a specially designed three-position control unit has been added whereby not only the heating element of the production process is controlled but also the cooling system. (Kelvin & Hughes (Industrial) Ltd.)

*

Vapour loss from volatile liquids in storage is minimised with floating cover of unplasticised PVC covering surface of liquid. Reduction of explosion hazard also claimed. (Laroche Frères, France.)

*

Bead form of benzoic acid, technical, eliminates sneezing nuisance experienced by operatives working in benzoic acid dust atmosphere. (Hooker Electrochemical Co., U.S.A.)

*

Automatic recording balance for measuring the settling rates and, indirectly, the particle size distribution of the solids in slurries. Novel method is used to make the system automatic in operation and of recording the data as a complete settling-rate curve. An overall sensitivity of 2 mg., full-scale response time of 10 sec. and a high degree of stability can be obtained, it is claimed. Can be adapted for study of slurries at elevated temperatures. (Developed at Battelle Institute, U.S.A.)

*

New quality of *Igurit* impervious graphite is stated to be alkali- as well as acid-proof. A coefficient of thermal conductivity of 120 Kcal./hr./°C./m. is quoted. Material has been used successfully for manufacture of heat exchangers of tubular and of plate types working under pressures up to 6 atm. as well as for pumps for corrosive liquids. (VEB Electro-chemisches Kombinat, Germany.)

*

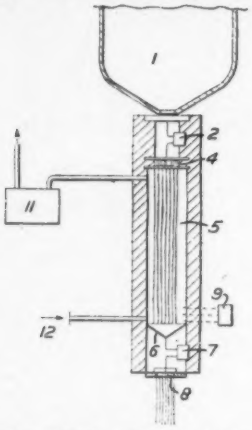
Completely self-contained dehumidifier, portable and designed to give constant relative humidity. Duty of the unit will vary according to conditions, but, according to the makers, with a temperature of 70°F. with a relative humidity of 70%, one unit will remove 35 lb. of water from the air in 24 hr. at an operating cost of less than $\frac{3}{4}$d./hr. Operates on heat-pump principle. (Bastian & Allen Ltd.)

Chemical Engineering Invention

RECENT BRITISH PATENT CLAIMS

Evaporating liquids

Monomeric constituents are removed from polymeric lactams by squirting the molten polymer through a nozzle 4 into a jacketed tube 5 which is maintained at a sufficient temperature to keep the threads in liquid form. A current of nitrogen introduced through a pipe 12 helps to carry off



monomers which collect in a chamber 11. The threads fall into a sump 6, the depth of material in which is regulated by contacts 9 which control the delivery of the pump 2 supplying the polymer to the nozzle 4.—693,376, *Inventa Akt.-Ges., Fur Forschung und Patentuerwertung.*

Alumina from slags

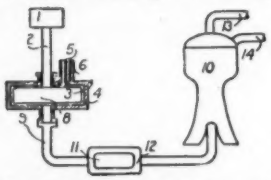
In order to facilitate the extraction of alumina from slags, an agent is added, in powdered, granular, liquid or gaseous state, to alter the composition of the slag under such conditions that the mass remains molten, cooling being effected slowly. The additional agent may be preheated in order to assist in maintaining the molten condition of the mass, or may be combustible or of such a composition as to combine with one or other of the constituents of the slag or of the other added agents to produce an exothermic reaction; such substances comprise calcium sulphide, iron sulphide, calcium carbide, silicon, aluminium, magnesium, carbon, hydrogen, and hydrocarbons. Air or oxygenated air can be blown through the molten mass to combine with any sulphur present as calcium sulphide, the air and the evolved sulphur dioxide aiding in causing complete mixing.

To ensure complete mixing of the mass and so to facilitate the reactions, manganese, titanium, sodium, potassium, barium, or calcium, or their oxides, sulphides or halides can be added. In a slag comprising alumina, lime and silica, ferrous oxide is added to combine with any free silica or to displace it from combination with alumina and lime and so reduce the amount of insoluble silico-aluminates present; the ferrous oxide may be added in the form of rolling-mill scale.

Iron pyrites may be added instead of ferrous oxide so that, by blowing, oxidation is effected and additional heat produced. Gypsum may be employed in conjunction with the pyrites as an oxidising agent. If a self-pulverising product is desired, the percentage of ferrous oxide added is less than four times the ratio between the lime and silica.—693,612, *Soc. Anon. de Commentry, Fourchambault & Decazeville.*

Purifying fatty oil

The specification refers to the continuous refining of fatty oils to remove free fatty acids therefrom by quickly mixing a suitable proportion of lye therewith in a mixer and then immediately separating the soapstock formed in a centrifugal separator. The mixing is effected in a regulatable-speed mixer. The mixture is watched through an inspection glass disposed in a pipe between the mixer and the separator, and the mixing is kept below the emulsification limit between the oil and lye by increasing or reducing the



speed. So long as particles are visible through the inspection glass, an emulsion is not being formed.

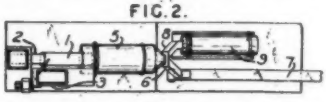
The process enables strong mixing to be applied to oils built up from fatty acids of high molecular weight, such as rape seed oil which is built up mainly from erucic acid, where the emulsification risk is low. It also enables a milder mixing to be applied to oils built up from fatty acids of low molecular weight, such as coconut oil which is built up mainly from lauric acid, where the emulsification risk is much greater.

In a suitable plant comprising a rotary mixer 3, consisting of a rotating disc 8 within a housing 4 for mixing and atomising the oil and lye supplied through inlets 5 and 6, respectively, a short pipe connection 9 and a separator 10, a speed adjustment device 1 of any known type influencing the shaft 2 of the mixer is provided, together with a device 12 having an inspection glass 11 in the pipe connection 9. Purified oil is discharged from the separator through pipe 13 and soapstock through pipe 14. Either the lye or the oil or both may be heated to 70°C. or more before being fed to the mixer. — 692,764, *Aktiebolaget Separator.*

Superphosphate

An apparatus for the production of superphosphate comprises a reaction mixer where the reacting acid and ground phosphate rock are mixed to form a slurry, a first rotary reaction conditioner into which the slurry is introduced, a second rotary conditioner for effecting granulation, a conveyor leading to a maturing or storage pile

FIG. 2.



and means for selectively causing the product to pass either to the conveyor and thence to storage, or to the second granulating conditioner whereby superphosphate in ordinary form or granular form can be produced at will.

In Fig. 2, a mixer 1 is fed with phosphate from a conveyor 2 and acid from vessel 3 to form a slurry which is passed into a rotating drum 5. The mixture is then passed through either pipe 6 to a conveyor 7 to storage or through a pipe 8 to a granulating drum 9.

Operating conditions referred to are (*a*) 100 parts of greased American phosphate are mixed with 64 parts of sulphuric acid monohydrate diluted to 130°Tw, and (*b*) Gafsa phosphate (100 parts) are mixed with 66 parts of sulphuric acid monohydrate diluted to 127°Tw. Specifications 559,482 and 625,863 are referred to.—693,498, *Sturtevant Engineering Co. Ltd., H. Richardson & Co. (York) Ltd., J. T. Proctor and A. Ogilvie.*

★ Personal Paragraphs ★

★ **Mr. Gilbert Dodd** has been appointed to the board of Monsanto Plastics Ltd. He has been general manager of the company since its formation as a subsidiary of Monsanto Chemicals Ltd., and he joined Monsanto's sales division in 1939. In 1949 he was appointed manager of the plastics department.

★ **Dr. J. T. McCombie** has been appointed general sales manager of the British Industrial Solvents Division of the Distillers Co. Ltd.

★ **Mr. P. M. K. Embling,** manager of the new chemical plant division of the Power-Gas Corporation Ltd., has spent part of his service with the company in India. After his return from India his activities were chiefly in the technical sales field with special reference to plants for the production and purification of synthesis gases. He was appointed technical sales manager in 1952.

★ **Dr. Thomas Girtin** recently retired from the chairmanship of Johnson & Sons Smelting Works Ltd. He joined the board of the parent company, Johnson, Matthey & Co. Ltd., in 1921 from Raphael's refinery, where he had been general manager, and remained on that board until 1952. His appointment to the chairmanship of Johnson & Sons Smelting Works came in 1930 after he had been actively concerned in the amalgamation of the two companies. Amongst his early work for Johnson, Matthey were the reorganisation and integration of the refineries at Hatton Garden. Later he was responsible for building the research laboratories at Wembley and for their organisation. He also prepared the plans for rebuilding the head offices at Hatton Garden and supervised this work until the war caused it to be suspended.

★ **Mr. R. H. Collcutt** has been appointed head of the operational research section of the British Iron and Steel Research Association, in succession to **Mr. R. T. Eddison.**

★ **Mr. H. V. Potter,** chairman and managing director of Bakelite Ltd., is to be relieved of the position of managing director from October 31, but he will continue as chairman. **Mr. F. J. Robinson** will vacate the position of deputy managing director as from the same date. The board has appointed **Mr. G. W. Hodds** as managing director as from November 1.

Dr. T. Girtin.

Mr. P. M. K. Embling.

★ **Mr. Eric A. Bevan,** managing director of Styrene Co-Polymers Ltd., is on a visit to South Africa. As well as contacting the company's customers in the Union, he is delivering a lecture to each section of the Oil and Colour Chemists' Association in Johannesburg, Durban and Cape Town. He will leave for return to England on October 19.

★ The Ministry of Supply announce that **Dr. E. A. Perren** has been appointed chief superintendent, Chemical Defence Experimental Establishment, Porton, with effect from September 1, 1955, in succession to **Mr. S. A. Mumford.** Dr. Perren, who is 55, has been superintendent of research, C.D.E.E., since 1951. Before that he was for two years chief superintendent of the Canadian Research and Development Establishment, Alberta.

★ **Dr. G. Tugendhat** has been appointed deputy chairman of Manchester Oil Refinery (Holdings) Ltd.

★ **Mr. John P. Holmes,** vice-president of Celanese Corporation of America, has been elected to the board of directors.

★ **Mr. W. E. Bryden,** a director of George Scott & Son (London) Ltd., recently left for Canada and the U.S. on a six weeks' business trip. He is in charge of the soda recovery section, in connection with the paper trade, and the primary intention of his visit is discussions with various pulp and paper firms.

★ **Dr. E. T. Murdock,** quality-control manager of T. Wall & Sons (Meat Products) Ltd., has been appointed assistant refinery manager in the London area for the British Oil & Cake Mills Ltd.

★ **Mr. A. W. Brace** has taken charge of surface finishing activities of the chemical division of Aluminium Laboratories Ltd., Banbury.

★ **Mr. V. Young,** F.C.I.S., has been appointed chairman of International Combustion Ltd. **Mr. W. Grainger** and **Mr. J. Mayer,** who were recently appointed joint managing directors of International Combustion (Holdings) Ltd., have also been appointed as joint managing directors of International Combustion Ltd.

★ **Dr. Norman A. Shepard** has retired from his post as chemical director of American Cyanamid Co., U.S.A. He joined Cyanamid in 1936 as director of technical service and was named to his most recent post in 1941.

★ **Mr. N. A. Richardson** has been appointed technical adviser to the Association of Tar Distillers. He will devote much of his time to wood preservation and he will work with, and have the facilities of, the Coal Tar Research Association.

★ **Mr. A. W. Hanson,** until recently manager of the Karachi office of Babcock & Wilcox Ltd., has been appointed by the company to the managership of their Newcastle office. **Mr. P. R. Bettle** is his deputy.

World News

GREAT BRITAIN

Phthalic anhydride

Monsanto Chemicals Ltd. announces that it has authorised expenditure of more than £500,000 for the construction of a new plant to manufacture phthalic anhydride at its Newport, Mon., factory. The new plant is expected to be in operation towards the latter end of 1957.

Representing a very substantial addition to Monsanto's present output of phthalic anhydride, which has been manufactured at its Ruabon factory since 1936, the new plant will bring the company's total production of this essential chemical raw material up to some 15,000 tons p.a.

The company state that the decision to provide the additional capacity is the result of the steadily increasing demand from the British paint, plastics and related industries, which export a high proportion of their products. Direct export of part of the additional phthalic anhydride production is also envisaged.

Phthalic anhydride is used in the manufacture of polyester resins; of alkyd resins used in many types of surface coatings and industrial finishes; in the manufacture of phthalic esters used as solvents, plasticisers and insect repellents; and in the production of numerous pharmaceuticals and dyestuff intermediates.

Titanium melting plant

A new plant for the melting of titanium on a production basis is being constructed by Wm. Jessop & Sons, Sheffield. Due to be completed by the end of 1955, this plant is the result of an exchange of ideas with the leading titanium manufacturers in America and is claimed to be the most modern of its type. Ingots of up to 300 lb. will be produced in sizes of 12-in. diameter and from 300 to 2,000 lb. weight in sizes of 20-in. diameter. The company state that these ingot sizes will enable all the range of wrought products envisaged to be processed using ideal conditions. The initial output of this plant will be approximately 350 tons of ingots p.a., but provision has been made for the capacity to be extended.

Within the two main alloy categories, alpha and alpha + beta, Jessops will manufacture various grades of titanium under the trade name of *Hylite*. Not yet a commercial proposition, the beta category will be investigated for potentialities.

Gas production increase

New gas-making capacity to a total of 137 million cu.ft./day was completed and brought into operation during the year ending March 1955. This is approximately 5% of the capacity available at the beginning of the year. Figures issued by the Gas Council show that the production of coal gas during the year increased by 1.6% and the quantity of coal used by 1.3%, but water-gas production increased by 20% and the use of oil in water-gas by 24½%. It is of interest to note that in the year the gas industry used nearly 7 million gal. of heavy oil in oil gasification plants and in water-gas plant.

The quantity of gas purchased from coke ovens and oil refineries increased by nearly 7½%.

New divisions for Power-Gas

The establishment of five specialised divisions is announced by the Power-Gas Corporation Ltd. The company, along with Ashmore, Benson, Pease & Co. and Rose, Downs & Thompson Ltd., both members of the Power-Gas group, engages in the manufacture of heavy industrial process plant and equipment. Five main product groups are occupying the attention of the company and each of the specialised divisions will concentrate its attention on the selling and production of specialities and on the further development of its particular field of activities.

The five new divisions and their respective heads are: Works Division (Mr. T. K. Hargreaves, director); General Contracts Division (Mr. C. Ingman, divisional director); Gas Plant Division (Mr. T. H. Riley, divisional director); Chemical Plant Division (Mr. P. M. K. Embling, divisional manager); and the Blast Furnace Division (Mr. D. R. Brown, divisional manager).

Chemical engineering lectures

A course of six lectures on 'Chemical Engineering in Industrial Processes' is to be held at the Technical College, Bradford, on Wednesday evenings from November 2 to December 7. Subjects to be covered include process design; chemical engineering in medium-sized dyestuffs intermediate works and in the coal-tar industry; chemical engineering problems in dyestuffs manufacture; effluent disposal problems in the chemical and allied industries; and heat conservation in chemical engineering.

Centrifugal pumps for Argentine

An order for 144 rubber-lined centrifugal pumps for the Argentine has been placed with Wilkinson Rubber Linatex Ltd., who state that the order was obtained in the face of international competition. Negotiations were conducted with the Instituto Argentine de Promocion del Intercambio and the pumps will be used by the Argentine mining industry for handling abrasive slurries.

Powell Duffryn's progress

The slow progress which has been made in Britain in the more efficient use of solid fuel was referred to in the annual statement by the chairman of Powell Duffryn Ltd., Sir Herbert Merrett. After praising the work of the National Industrial Fuel Efficiency Service, he pointed to the need for much greater economies through the improvement of combustion conditions and appliances in the boiler house, etc. It appeared to him to be up to the customer to co-operate in what now becomes a national obligation.

Referring to Powell Duffryn Carbon Products Ltd., the subsidiary company which produces heat exchangers and related articles of equipment, Sir Herbert stated that, in the year under review, there was a marked improvement in the financial results.

New T.I. research station

The establishment of an applied research station at Walsall to supplement facilities already available at its research laboratories at Cambridge and Birmingham is announced by Tube Investments Ltd. The new station will initially house three sections of the group's technological department, which acts as a bridge between fundamental scientific work and its practical application in the group's operating companies.

The irradiated materials section at Walsall will be directed by Dr. A. Charlesby, formerly of the Atomic Energy Research Establishment, Harwell. Its development work will cover a wide field, but will be particularly concerned with irradiated plastics. The materials will be irradiated in the first instance at the Tube Investments' research laboratories at Hinxton Hall, Cambridge, where an electron accelerator is being installed.

The plastics development section will be directed by Mr. J. E. Gordon, formerly head of the plastics development organisation at the Royal Aircraft Establishment at Farnborough. This section will be concerned with the development of processes and the necessary machines to be used in the

As reported in our September issue, the Dano 'Bio-Stabilizer' for the rapid composting of domestic and other refuse, is being tried out by Edinburgh Corporation. Here is a view of the Edinburgh installation from the feeding end. The lorry glimpsed beyond the brick building is backed under the delivery chutes.

plastics industry to take advantage of the chemical advances of recent times, to the streamlining of production techniques, and its impact upon end-product design.

A further team at Walsall will operate under the direction of Mr. C. A. Cochrane and will be concerned with control engineering, including the application of electronic techniques to industrial processes.

Exhibition at Farnborough

A greatly enlarged exhibition of equipment was at Farnborough this year in connection with the flying display organised by the Society of British Aircraft Constructors. The exhibition included both covered and uncovered sections and among the items shown were vessels for the storage and transport of inflammable and corrosive liquids; fire and explosion protection systems; aluminium alloy plate, sheet, etc.; *Staybrite* stainless, heat- and creep-resisting aircraft steels; *Fibreglass* reinforced plastics; titanium and titanium alloys, etc. Among other interesting items were a special bowser for the transport of high-test peroxide and a large, static, oxygen-producing plant.

Training in industrial instrumentation

A dinner given by Honeywell-Brown Ltd. in London recently marked the end of the first nine-weeks' course in industrial instrumentation at the company's recently established training school. This course was for 'internal' training. Half the students were employees of Honeywell-Brown, the rest were sent by other European countries within the International Division of the Minneapolis-Honeywell Regulator Co.

The school is fully equipped to provide intensive training in all aspects of industrial instrumentation. Fundamentally the aim is to teach by lecture and laboratory practice the theory, operating characteristics, industrial applications and maintenance of the company's instruments and automatic controls. Besides offering customer and basic training courses the school will keep trained men up to date by providing refresher courses as often as possible.

Customer courses will commence in the near future and are already heavily booked, the company state.

Nickel plating

The *Kanigen* process of chemical nickel plating will be available in 1956 in the United Kingdom. Albright & Wilson Ltd. have signed an agreement with the General American Transportation Corporation, who developed the process, whereby the British firm become the sole licensees for the United Kingdom, Eire and Denmark.

Described as an entirely new material, *Kanigen* plate can be applied to metal, glass, plastics and ceramics and is claimed to provide a uniform, hard, non-porous coating on components of any shape; it is a nickel-phosphorus alloy containing about 8½% of phosphorus.

Industrial accident prevention conference

Sir Ewart Smith, deputy chairman of Imperial Chemical Industries Ltd. and chairman of the British Productivity Council, is to be one of the speakers at a one-day conference on industrial accident prevention which is to be held in London on October 28. The conference is being organised by the London Industrial Co-ordinating Committee, which represents five industrial accident prevention groups who work in and around London. The Industrial Safety Division of the Royal Society for the Prevention of Accidents is also closely connected with the conference.

Admission to the conference is by tickets available from the hon. treasurer, Mr. H. Meanley, North Thames Gas Board, Fulham, London, S.W.6, at 10s. 6d. each.

Fuel efficiency

The third post-war Fuel Efficiency Exhibition will open on October 12 at the City Hall, Manchester, where some 100 firms will demonstrate solid and liquid fuel economy for all branches of industry.

Fatty acids transport

Two tankers are now used regularly for the road despatch of bulk quantities of fatty acids by Hess Products Ltd. They are of stainless steel, of the single-compartment type and have pumps and heating coils fitted. Each carries 12 tons of fatty acids.

Hess make their *Distec* range of fatty acids in the fractional distillation unit at Littleborough, near Rochdale. In the near future they will also be making the Armour range of nitrogen derivatives of their fatty acids which will be offered for sale by Armour & Co. Ltd., London.

Corday-Morgan medal and prize

An announcement from the Chemical Society concerning the above award points out that applications or recommendations in respect of the award for the year 1954 must be received not later than December 31, 1955, and applications for the award for 1955 are due before the end of 1956.

This award, consisting of a silver medal and a monetary prize of 200 guineas, is made annually to the chemist of either sex and of British nationality who, in the judgment of

the Council of the Chemical Society, has published during the year in question the most meritorious contribution to experimental chemistry and who has not, at the date of publication, attained the age of 36.

NORTHERN IRELAND

Peat as raw material for activated carbon

The Northern Ireland Minister of Commerce recently announced the completion of negotiations with the British Ceca Co., London, for the establishment of a new industry in the Londonderry area for the manufacture of activated carbon, using peat as a raw material.

The output from the new factory will represent the first United Kingdom source of peat-based activated carbon and the firm has stated that a ready market is assured in the United Kingdom and Commonwealth whose demands for this type of activated carbon have hitherto been met from Continental sources.

A new company, Ceca (N.I.) Ltd., has been formed to operate the venture, with the participation of Charles Tennent (N.I.) Ltd. The firm plans to erect a factory on the outskirts of Londonderry and preparatory work has already commenced. Production is scheduled to start in 1956.

The establishment of this new industry results from the peat survey carried out by the Ministry's Department of Industrial and Forensic Science during the last three years. Samples of peat from various areas in Northern Ireland were examined and despatched to the London company for testing before a decision was reached to locate a factory at Londonderry.

The British Ceca Co. Ltd., the parent company, initiated and engineered the project.

Activated carbon is used in industry as a purifying agent and decoloriser.

FRANCE

Uranium project

The formation of the Compagnie Francaise des Minerais d'Uranium was officially announced recently. The company has been founded by Rothschilds Freres in co-operation with mining and chemical firms including Pennarroya, Le Nickel, Etablissements Kuhlmann, Pechiney, Compagnie des Mines de Huaron and Minerais & Metaux.

According to the *Financial Times*, it will have an initial capital of 400 million francs, of which 15% will be subscribed by the State Atomic Energy Commission. It will explore, prospect, mine and process deposits of fissile materials in France and possibly abroad.

The Leonard Hill Technical Group—October

Articles appearing in some of our associate journals this month include:

Paint Manufacture—Improved Plant for Paint Manufacture; New Installation in Australia; Keeping the Paint Factory Within the Law; Conjugation in Drying Oils.

Food Manufacture—International Bakers' and Confectioners' Exhibition; Texture in Fruit and Vegetables; Garden Peas from a Midlands Cannery; Better Food for India's Millions; Food Additives and Food Labelling; Research at INACOL; Caviare for World Markets; Old-time Potted Meats.

Manufacturing Chemist—Improving Yields in Antibiotics Manufacture; The Analysis of Polyethylene Glycols and their Derivatives; Hexachlorophene and Perfumes; Smith a Nephew Ltd.'s new 'Elastoplast' Factory in S. Africa; Progress Reports: Cosmetic and Toilet Preparations, Fertilisers and Plant Nutrients, and Analytical Chemistry.

Fibres—Softening Hard Cuttings of Jute with Diammonium Hydrogen Phosphate; Orlon Acrylic Fibre; The Uster Spectrograph: Its Application in the Man-made and Synthetic Fibre Industries; Flock Printing: A Growing Fashion; Improving Natural Fibres; Molecular Bonding Aids New Textile Finishing Processes.

Petroleum—Stores Operations in the Oil Industry Overseas; Control of Engine Knock through Gasoline and Air Composition; Focus on Rheology.

Corrosion Technology—Magnetic Treatment of Water; Corrosion Problems in Dyeing and Finishing Works; Painting of Ships; Important Advances in Bituminous Products.

Atomics—Report 2 on the International Conference and Exhibition on the Peaceful Uses of Atomic Energy; Radiological Defence Instruments: The NATO Conference; Handling Plutonium in Laboratories.

Dairy Engineering—The Choice of Vehicles for the Perfect Delivery Service; Battery Charges for the Electric Delivery Vehicle; Milk Distribution in New Zealand; Vehicles for the Transport of Milk in Bulk; Training the Milk Salesman; Transport for Feeder and Pick-up Routes; Milk Consumption North of the Border.

VENEZUELA

Fertiliser and chlorine plants

The Venezuelan subsidiary of a United States' construction firm was awarded the contract for the construction and installation work required in connection with the projected fertiliser and chlorine plants of the Petroquimica Nacional.

NETHERLANDS

Epichlorhydrin plant

The Shell Petroleum Co. Ltd. have announced from their London office that a new plant is now being built at Pernis, near Rotterdam, to manufacture epichlorhydrin, one of the two key ingredients of epoxide resins. Production is expected to begin in September 1956.

At present, epichlorhydrin is available only from the United States. For its manufacture in Holland, use will be made of the technique known as 'hot chlorination,' consisting in the substitution of chlorine for one of the hydrogen atoms in propylene recovered from refinery gases. The allyl chloride so produced can be further processed to either glycerol or epichlorhydrin.

Apart from its use in the manufacture of epoxide resins, epichlorhydrin, being a highly reactive bi-functional intermediate, is finding increasing application for chemical synthesis. Already established are such uses as an intermediate for the manufacture of surface-active agents, ion-exchange resins and pharmaceuticals, whilst it is being increasingly employed as a stabiliser for chlorinated hydrocarbon insecticides.

Epoxide resins, marketed by Shell under the name *Epikote*, find their largest outlet in the manufacture of high-quality surface coatings. The other important ingredient of these resins, di-phenylol propane, is already manufactured at the Stanlow chemical plant in Cheshire.

Foreign investment

A survey of foreign participation in Dutch industry shows that at the end of June 1955 there were in this country 76 subsidiaries of foreign companies (of which 47 had their parent company in the United States) and 103 cases in which foreign concerns were participating in or co-operating with Netherlands' firms. Of the 76 subsidiaries, 36 were in the metallurgical sector, as were 44 of the participations.

Fertiliser-from-sea-water plant stops work

The experimental factory set up in Ijmuiden some years ago by N.V. Norduco (a joint Norwegian-Dutch concern) for the distillation of salt from sea water for the production of fertiliser has stopped work. A report from the Board of Trade in London suggests one of the factors leading to this decision was the availability of waste products with a reasonably high grade of potassium from Germany at a rate which made the distillation process uneconomical.

The two tankers used by Hess Products for transporting fatty acids.

CANADA

Vinyl resin and PVA

Shawinigan Resins Corporation, one of the companies associated with Shawinigan Chemicals Ltd., has announced plans for construction of two new plants. A large plant will be constructed at Trenton, Michigan, to increase the company's production of *Butvar*, a vinyl resin used in the manufacture of safety glass, and new facilities will be built at Springfield for the production of *Gelvatol* polyvinyl alcohol by a new process developed at Shawinigan Chemicals' plants at Shawinigan Falls. Both new plants are expected to be completed by the end of 1956.

Olin Mathieson in Canada

Olin Mathieson Chemical Corporation (U.S.A.) has established a Canadian branch office of its Industrial Chemicals Division in Montreal. This step, the company state, has been taken in view of the increasing industrial growth of Canada and the expanded needs of the nation for industrial chemicals.

SPAIN

Industrial projects

Union Quimica del Norte de Espana will spend 28 million pesetas on a plant for producing some 2,000 tons p.a. of polythene. Of this amount, 15 million pesetas will be expended on the import of various items such as compressors, high-pressure heat exchangers, reducing valves, etc.

Authority has been granted to Union Espanola de Explosivos to erect new plant for the production of special-quality nitrocellulose. This plant is intended to increase the company's daily output of this kind of nitrocellulose from its present figure of 1 ton to 3 tons. The new installation will take two years to complete and it will cost 21 million pesetas, of which 11 million will be expended on imported components.

An extension to the works of Nitratos de Castilla has been declared ' of national interest.' This firm is one of the leading producers of nitrogenous fertilisers.

THAILAND

Oil refinery

The Ministry of Defence proposes to set up an oil refinery in Bangkok with an intake of 5,000 bbl./day of crude oil. The crude oil is to be bought from the foreign oil companies established in Thailand.

GUATEMALA

Research centre

A Central American Research Institute for Industry is being set up in Guatemala City under United Nations' auspices. The institute is to advise all Central American countries on industrial development.

INDIA

Steel plant

The Indian Government has approved a British plan for a 1,100-million-rupee (£82 million) steel plant with a capacity of 1 million tons p.a. The plant's main products will be medium and light sections and billets for forging and re-rolling as well as pig iron. It will be the third new Government-owned plant and will be built as part of the Government's aim to achieve an annual steel ingot output of 6 million tons.

JAPAN

Potassium chloride

The Nichimen Jitsugyo Co., the Iwai Sangyo Co. and the Sogo Boeki Co., import/export merchants, have signed a barter contract with East Germany to import 45,000 tons of potassium chloride valued at $3,120,000 on a back-to-back basis at $68 to $69 per ton c.i.f. in exchange for iron and steel products and cotton.

SWITZERLAND

Chemical firm's exports

The annual report of Sandoz A.G., Basle, states that almost 95% of the concern's production is exported. To spread the risks of such a degree of dependence on foreign market conditions, less emphasis is being placed on the dyestuffs division and more on other products, particularly pharmaceuticals. A considerable degree of capital investment is envisaged in the report.

NYASALAND

Calcium phosphate deposit

A large deposit of calcium phosphate has been found at Natache Hill, two miles south of Lake Chilwa at the southern end of Nyasaland. The Department of Geological Survey said that preliminary investigation had revealed a deposit of over 3 million tons, and there may be considerably more.

PERU

Fertiliser project

A local concern, Compania Financiera del Peru S.A., has launched a scheme, with Italian financial and technical backing, for the manufacture of nitrate of ammonia. The new concern, Fertiza Limitada, has a capital of $4 million and its machinery will be manufactured by the Italian Ansaldo combine from patents owned by Montecatini. Technicians from the latter will supervise the new factory, which is expected to go into production in the second half of 1956.

FINLAND

Industrial developments

The State-owned company, Neste Oy., has entrusted the U.S. Lummus Co. with the planning of an oil refinery to be constructed at Naantali. The refinery will have capacity to produce at least 700,000 tons p.a. of oil products.

Borings for molybdenum in two areas in the Oulu province are now taking place, and annual production of some 300,000 tons of ore from the Vihanti mine in the province of Oulu,

containing zinc, lead, copper and sulphur, is planned for export to Belgium for refining.

A vanadium extracting plant is to be built at the Otanmäki iron mine, whose main products are ilmenite and magnite.

Four cellulose mills are building plant for burning waste lye in order to cut down fuel consumption.

PAKISTAN

Dyestuffs factory proposed

An agreement has been signed between the P.I.D.C. and a group of German firms for the setting up of a dyestuffs factory in Pakistan to produce, in the first instance, Congo red and sulphur black. The German participants are to supply 30% of the capital. The agreement is subject to ratification by the two governments.

CHILE

Fertiliser project

A project is under consideration for utilising the residual ash from the dumps of the Huachipato steel mills in the manufacture of fertilisers. The ash is said to be an excellent substitute for lime. Production would be about 150,000 tons p.a.

NORWAY

Aluminium plans

The Norwegian Ministry of Industry is considering plans for increasing the output of aluminium at the State-owned plant at Ardal, west Norway, to 60,000 tons p.a. The present output is about 24,000 tons p.a. The proposed production increase will require a large development of hydroelectric power, and a total investment of between £15 million and £20 million would be needed. Total Norwegian aluminium output now is about 70,000 tons.

UNITED STATES

Fertiliser process agreement

The United Steel Corporation of America have signed a contract with Montecatini (Societa Generale per l'Industria Mineraria e Chimica), the Italian chemical concern, for the manufacture of azote fertilisers by a new method discovered by Prof. Giacomo Fauzer, Montecatini's vice-president, at Geneva, some 30 miles from Salt Lake City, Utah.

Manufacture will be carried out at the U.S.C.'s new factory, now under construction, where the ammonia will be collected from the gases given off during the manufacture of coke.

This is the fourth contract to be signed for the overseas production of azote fertilisers by the new process. The Montecatini organisation recently reached agreements with the Governments of India, Colombia and Venezuela.

Calcined alumina

The Reynolds Metal Co. are producing calcined alumina, which is described as alumina fired at higher temperatures than metallurgical alumina. Applications range from abrasives production to use in refractories for lining tanks or furnaces.

Chemical 'tree rubber'

Manufacturing facilities will be built by Goodrich-Gulf Chemicals Inc. to produce its new man-made rubber, which is stated to be chemically and physically a reproduction of tree rubber. A pilot plant is to be located in northern Ohio and, when these facilities are completed, materials for testing will be available to other companies.

The company is owned jointly by the B. F. Goodrich Co. and the Gulf Oil Corporation.

New synthetic yarn

A new synthetic yarn, designed to retain the durability of man-made fibre and at the same time achieve the softness of natural materials, has been introduced by the Textured Yarn Co., Philadelphia.

The new yarn, *Tycora*, is a modified continuous-filament fibre. It has been made by applying one of seven modifying processes to nylon, the particular process depending on the end-use desired. The adaptation of other synthetic fibres such as *Dacron*, *Orlon* and rayon is planned also.

Sludge acid regeneration plants

Two sludge acid regeneration plants, costing about $8 million, were recently brought on stream by Consolidated Chemical Industries. These plants, located at Baytown and Houston, Texas, were designed and constructed by Chemical Construction Corporation. They add 280,000 tons p.a. of regenerated sulphuric acid to the company's already extensive sulphuric acid business with petroleum refineries in the south-west.

A unique design feature of both plants is the utilisation of the fuel value of the sludge itself. The sludge is decomposed in furnaces at elevated temperatures using only limited amounts of supplementary fuel.

Paper from nylon

Riegel Paper Corporation has produced its first commercial run of synthetic paper made wholly from nylon fibre. It is said to be almost impossible to tear this paper by hand and it is claimed to be many times stronger than paper made from rags or wood pulp.

The advantages achieved through incorporating nylon fibre suggest that the paper could be used for heavy-duty bags, for filtration of corrosive liquids and for packing chemicals. The costs are higher than for other types of paper, but this is expected to decrease as production increases.

BRAZIL

Asphalt plant

A Canadian firm has been awarded the contract for the building and equipment of an asphalt plant at Cubatao. Two contracts were involved; the first, covering preliminary planning and the siting of the plant, went to a local Brazilian company.

Petroleum expansion

Petrobras has signed contracts with M. W. Kellogg Co. and Batignolles-Chatillon for an expansion programme at Mataripe. The contracts are valued at a little over U.S. $9 million.

CHEMICAL & PROCESS ENGINEERING

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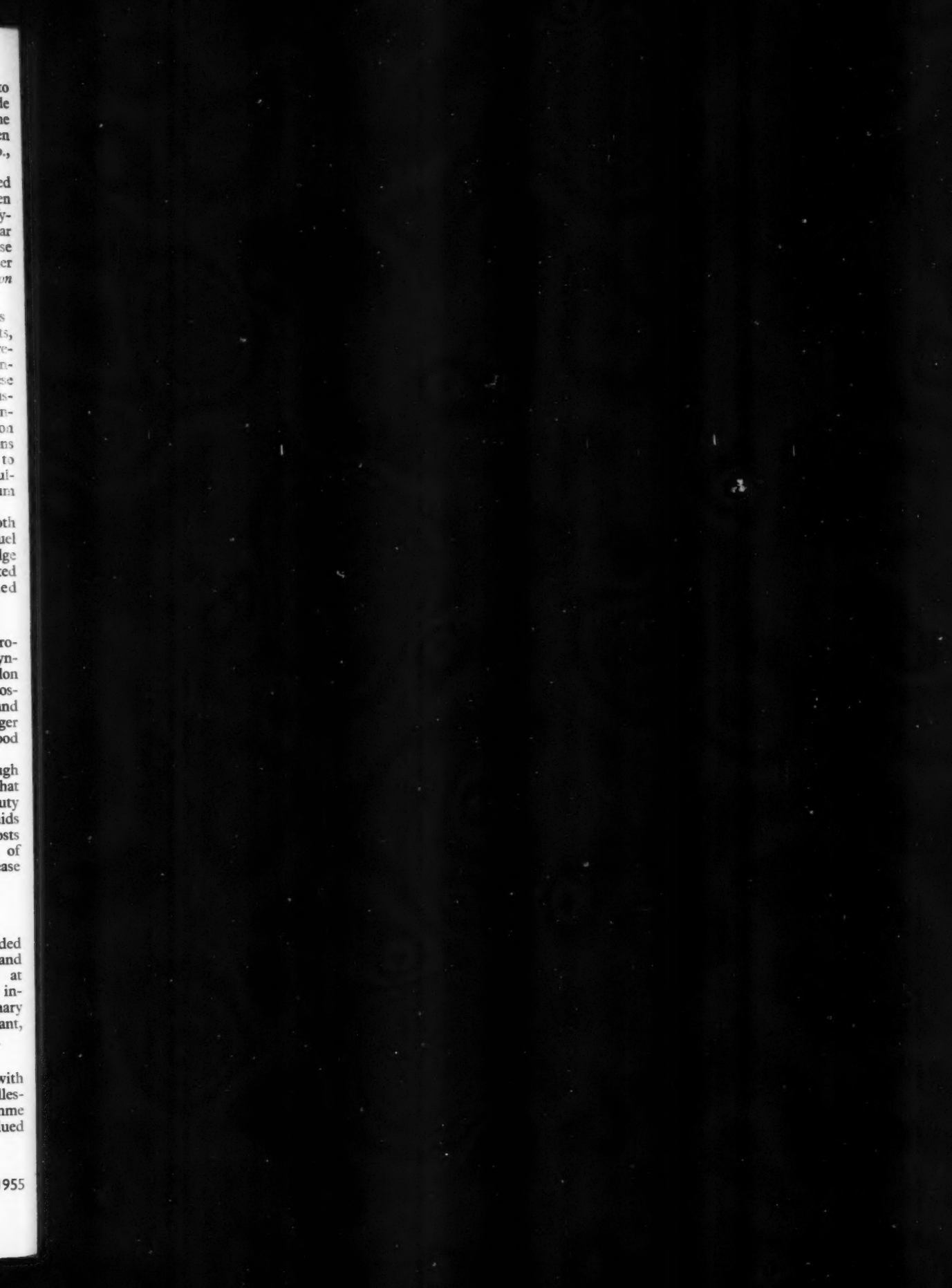
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